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Proceedings

REPORT
OF THE
OFFICERS CONSTITUTING
THE LIGHT-HOUSE BOARD,
CONVENED UNDER INSTRUCTIONS FROM
THE SECRETARY OF THE TREASURY,
TO INQUIRE INTO
THE CONDITION OF THE LIGHT-HOUSE ESTABLISHMENT OF THE UNITED
STATES, UNDER THE ACT OF MARCH 3, 1851.

FEBRUARY 5, 1852.

Read, Referred to the Committee on Commerce, and ordered to be printed.

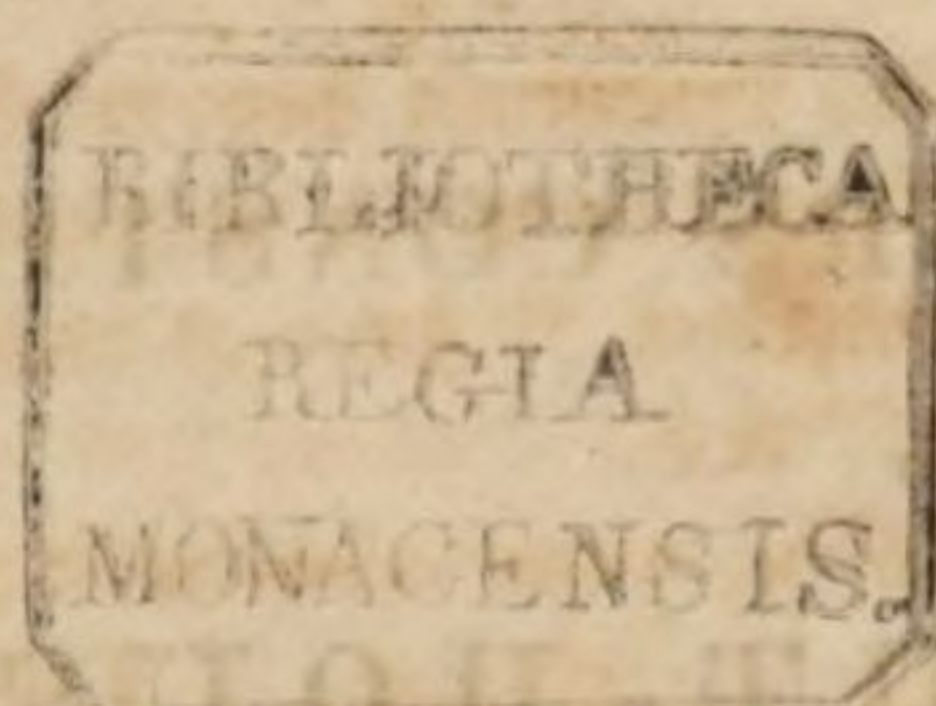
FEBRUARY 6, 1852.

Ordered, that 3,000 additional copies be printed, 1,000 of which for the use of the Light-House Board.

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THE LIGHT-HOUSE BOARD

CONTAINED UNDER REGISTERED TRADE MARK

THE SECRETARY OF THE TREASURY

The following report of the Secretary of the Treasury, in relation to the Light-House Board, was received by the Department of the Interior, and is hereby published for the information of the public.

The report of the Secretary of the Treasury, dated the 1st day of January, 1891, is as follows:

The Light-House Board, established by the Act of March 3, 1849, (10 Stat. 254), is a body corporate, created by the United States, and is organized under the provisions of the Act of March 3, 1849, and the Act of March 3, 1850, (10 Stat. 254, 255).

The Light-House Board is organized by the President, and is composed of the Secretary of the Treasury, the Secretary of the Interior, and the Secretary of the Navy, and is authorized to exercise the powers and perform the duties conferred upon it by the Act of March 3, 1849, and the Act of March 3, 1850.

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LETTER FROM THE SECRETARY OF THE TREASURY.

TREASURY DEPARTMENT,
February 4, 1852.

SIR: I have the honor to transmit herewith the report of the light-house board, appointed by the department in pursuance of the 8th section of the act of 3d March, 1851, entitled "An act making appropriations for light-houses, light-boats, buoys," &c.

Very respectfully, your obedient servant,

THO. CORWIN,
Secretary of the Treasury.

Hon. W. R. KING,
President pro tem., U. S. Senate.

TREASURY DEPARTMENT, May 21, 1851.

GENTLEMEN: By the 8th section of the act approved 3d March, 1851, entitled "An act making appropriations for light-houses, light-boats, buoys," &c., the Secretary of the Treasury is authorized and required to cause a board to be convened at as early a day as may be practicable after the passage of that act, to be composed of two officers of the navy of high rank, two officers of engineers of the army, and such civil officer of high scientific attainments as may be under the orders or at the disposition of the Treasury Department, and a junior officer of the navy to act as secretary to said board, whose duty it shall be, under instructions from the Treasury Department, to inquire into the condition of the light-house establishment of the United States, and make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection and superintendence.

Having been advised that the board has met, as directed by the department, has been organized by the election of Commodore William B. Shubrick as president, and is now prepared to proceed in execution of the duties assigned in the act of Congress, it is deemed proper briefly to refer to some of the more important subjects which will occupy its attention. By so doing, the department does not wish to limit in any way the range of the inquiries of the board, which, on the contrary, it desires may embrace all such matters relating to light-houses, beacons, buoys, and other aids to navigation, as may seem worthy of examination and report.

1st. The board is to inquire and report in regard to the condition of the light-house establishment of the United States; its efficiency and economy; the classification and distinction of the lights; the mode of ascertaining the proper places for light-houses and light-boats; the special selection of the sites of light-houses, and of obtaining their use; of procuring plans for the buildings and vessels, lighting apparatus and other accessories, such as

alarm signals, &c.; of determining the materials, and mode of construction; of procuring them, and of the superintendence while under construction, or of securing the faithful observance of contracts; the condition of its towers, and other buildings, and of its light-boats; of its lanterns and other accessories; the perfection or imperfection of its illuminating apparatus; the character of the ventilation of the lanterns; of the attendance upon the lights, of the general police and regulation of the establishment, and especially of the cleanliness of the lighting apparatus; the regularity of lighting and of extinguishing the lights, and of the mode of securing it; the modes of procuring and delivering supplies, and of testing their quality; of securing the services of proper persons as keepers; the manner and frequency of inspections, and the persons by whom made; the direction, making, and supervision of annual repairs; the mode of determining the position in which beacons, buoys, sea-marks, and other aids to navigation, should be placed; of procuring and placing them; of replacing them when removed, and of numbering and coloring the buoys; and, finally, in regard to the manner of giving notice to mariners in regard to changes in lights, beacons, buoys, and sea-marks.

It is desirable that the board should compare the condition of some of the light-house structures erected at an early period, (as the tower of Sandy Hook,) with that of more modern ones, and ascertain, if practicable, the causes of the difference, if any, in their durability; that a full comparison of the system of lighting adopted in the United States should be made with that of Great Britain and France in reference to useful effect—to economy in first cost and in annual repairs—to durability and efficiency; that the systems of illumination by the best reflectors and the Fresnel lenses should be carefully compared, and the advantages and disadvantages of either be fully stated; that the cost of the gradual introduction of the French or lens system should be carefully ascertained and compared, in a period of say five years, as to useful effect and economy, with the cost of continuing the present system.

It is desirable that a complete descriptive list of the light-houses, light-boats, beacons, buoys, and sea-marks in the United States, should accompany the report of the board.

The department will furnish all facilities to the board within its power for obtaining the information necessary to the discharge of its important duties, and will provide the books, maps, charts, and apparatus, which may be required.

Directions will be given to submit to the scrutiny of such of the members of the board as may be charged with that duty, any of the light-houses, light-boats, and their accessories, which they may deem it desirable to examine.

Besides the examination into the present system, the law requires a detailed report and programme to guide legislation in extending and improving the present system of construction, illumination, inspection, and superintendence.

The department, therefore, desires the views of the board on these subjects under the several heads heretofore enumerated, and expects a detailed plan for lighting the coast of the United States, showing the proper location of the sea-coast lights, and the best modes of arranging them in one system, having reference to classification and distinctive character.

It is desired that such a classification should be adopted as will be of

ready use, and include all sea and lake coast, bay, river, and harbor lights, and that such distinctive characteristics should be proposed as may be best adapted to the several classes and circumstances of the lights.

In connexion with the programme, the best means of ascertaining the necessity for the introduction of new lights, for supplying them, and for renovating old ones, should be pointed out. Suggestions in regard to the discontinuance of unnecessary lights will be expected from the board.

The department desires that the subjects on which instructions may be deemed necessary to persons employed in connexion with the light-house establishment, and the best mode of securing attention to them, should be pointed out.

The report of the board should also give in detail their views in regard to the different materials for constructing light-houses, to the mortars and cements which are or may be employed, and to the plans for foundations and superstructures adapted to different localities.

In all points in which the present system is deemed by the board inadequate or unsatisfactory, the department expects a detailed plan of reorganization.

Facilities for the foreign and domestic correspondence necessary to procure information will be afforded to the board by the department.

The board is requested to give any information which it may obtain in regard to improvements in the materials or modes of illumination in light-houses.

The department suggests to the board that it was doubtless the expectation of Congress that every practicable mode of securing the desired information should be adopted, in order to receive the results of the investigation in time to be submitted to the next session of Congress.

Very respectfully, your obedient servant,

THO. CORWIN,

Secretary of the Treasury.

Commodore WILLIAM B. SHUBRICK, *U. S. Navy,*

Commander S. F. DU PONT, *U. S. Navy,*

Brevet Brigadier General JOS. G. TOTTEN, *U. S. Corps of Engineers,*

Lieut. Col. JAMES KEARNEY, *U. S. Top. Engineers,*

Prof. A. D. BACHE, LL. D., *Superintendent Coast Survey,*

Lieut. THORNTON A. JENKINS, *U. S. Navy, Secretary.*

REPORT.

OFFICE LIGHT-HOUSE BOARD,
Washington City, January 30, 1852.

SIR: The light-house board have the honor to submit the report of their investigations, and the conclusions they have arrived at, under your instructions of the 21st May, 1851, hereto appended, in conformity to the eighth section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851, in the following words:

“*And be it further enacted*, That the Secretary of the Treasury be, and he is hereby, authorized and required to cause a board to be convened at as early a day as may be practicable after the passage of this act, to be composed of two officers of the navy of high rank, two officers of engineers of the army, and such civil officer of high scientific attainments as may be under the orders or at the disposition of the Treasury Department, and a junior officer of the navy to act as secretary to said board; whose duty it shall be, under instructions from the Treasury Department, to inquire into the condition of the light-house establishment of the United States, and make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection, and superintendence: *Provided*, That no additional compensation be allowed to any person serving on said board.”

The board, having entered upon the duties confided to them with a high sense of their responsibilities and importance, have spared neither pains nor labor in seeking to obtain facts, from their own observation and from reliable sources, upon the different points embraced in your instructions. They have sought for useful information also from reliable treatises and from public documents, and have endeavored to reach correct conclusions on the numerous points submitted to them.

The subject of light-house illumination and improvement, although one of occasional discussion in Congress and in certain circles within the last twelve or fifteen years, has not occupied the public mind to any great extent in this country; while in Europe generally, but more especially in France, England, Scotland, and Ireland, the ablest and most distinguished statesmen, philosophers, and philanthropists have devoted themselves for the last twenty-five or thirty years to this subject, in endeavoring to apply practically the aids which science and the mechanic arts have developed.

Experiments to ascertain the truthful practical tests of the relative useful and economical values of illuminating apparatus, combustibles, and their accessories, in the most minute detail, have been made by Fresnel, Faraday, Stevenson, and other distinguished individuals; the results of their investigations have been published to the world, and their conclusions have served for the formation of a system for light-house illumination, approximating to perfection.

Legislation, too, has taken a prominent part in this important branch of the public service in Europe.

In 1825 the French government adopted definitively the Fresnel system of illumination on the coasts of France, and took, as the basis of their fu-

ture light-house establishment, the programme proposed by the board organized for the purpose, at the head of which was Admiral Rossel of the French navy.

About this time the subject, which Sir David Brewster had foreshadowed in 1811, was revived in England and Scotland, through Colonel Colby, of the royal engineers, and Mr. Stevenson, the engineer to the Northern lights, (and the distinguished architect of the Bell-Rock tower.) However, no important step was taken on the English side of the channel to introduce the Fresnel apparatus until after a most careful and rigid examination had been made by the light-house engineer of Scotland, and after trials of comparative usefulness and economy with that and the reflector apparatus at the Inchkeith station.

In 1834 a new impulse was given to the subject of improvement in light-house illumination by letters from Sir David Brewster, and from the action of the House of Commons' select committee.

The light-house boards of Europe seemed to exert themselves to satisfy public opinion by the introduction of the Fresnel lens at a few of the most important points for land lights, and of improved apparatus for floating lights, consisting of the Argand lamps and parabolic reflectors in general use for land lights, prior to the introduction of the Fresnel lens, and movable machinery for converting such fixed floating lights as were necessary into revolving ones.

Although the lens met with much favor in England, and has been gradually getting into use, until nearly one-half the sea-coast lights have been changed since 1837, still Scotland has introduced a larger number, in proportion to extent of coast, than the Trinity-House corporation. Notwithstanding these decided improvements in the lights of Great Britain, another select committee on light-houses was raised by the House of Commons in 1845, and, of the benefits arising from this last report, have been the introduction of a large number of lens apparatus, not only in Great Britain, but also into many of the colonies, and the substitution of the colza or rape-seed oil in nearly every light-house in the kingdom, in consequence of its superiority and economy compared to the best sperm oil.

Improvements in illuminating apparatus and construction, ventilation, combustibles, &c., have made rapid progress in light-house engineering in Europe; while in this country no attempt has been made to improve the lights, with the exception of the act of Congress approved July 7, 1838, and which was the result of the recommendation of the Committee on Commerce in the Senate, as follows:

"SEC. 2. *And be it further enacted*, That the Secretary of the Treasury be, and he is hereby, directed to cause two sets of dioptric or lenticular apparatus—one of the first, the other of the second class—and also one set, if he deems it expedient, of the reflector apparatus, all of the most improved kinds, to be imported, and cause the said several sets to be set up, and their merits, as compared with the apparatus in use, to be tested by full and satisfactory experiment."

Under this authority a lens apparatus was placed in each of the towers at the highlands of Navesink, and fourteen out of the fifteen reflectors were placed in the Boston light-house.

If "the said several sets" were "set up" and "their merits, as compared with the apparatus in use, tested by full and satisfactory experiment," in conformity to the act, the results of those experiments have not been

seen by the board, nor have they ever heard that such experiments were made. With this exception, and the authority of Congress "to test Mr. Isherwood's plan of discriminating one light from another, and of determining the distance of a vessel from a light," which resulted in placing a second order lens in the tower at Sankaty Head, Nantucket, and the lights authorized by law to be constructed under the direction of the Topographical Bureau, (Brandywine shoal, Carysfort reef, and Sand key,) the board have been unable to discover that any steps have been taken to keep pace in light-house improvements in this country with those of France and Great Britain.

The board, after examining, with a patience and a zeal which they believe this important branch of the public service to demand, the different points to which their attention was specially called by the instructions of the department, have arrived at the following conclusions, which they feel assured will be found to be fully sustained by the detailed data in this report, and its appendix, upon which they are chiefly based :

1. That the light-houses, light-vessels, beacons, and buoys, and their accessories in the United States, are not as efficient as the interests of commerce, navigation, and humanity demand; and that they do not compare favorably with similar aids to navigation in Europe in general, but especially with those of France and Great Britain, and their dependencies.

That the light-house establishment of the United States does not compare favorably in economy with those of Great Britain and France.

That, while the superiority of the European lights to those of the United States (arising from the greater care and attention bestowed upon them, the better and more expensive apparatus employed in them, the larger number of keepers to the lights, the more rigid superintendence and frequent visitations for inspections and for delivery of supplies) renders any just comparison of them in annual expense in money impossible, it is shown that the difference for maintenance per lamp per annum is very small, and that not invariably in favor of those of this country.

That the towers and buildings have not been constructed in general of the best materials, nor under the care and supervision of competent or faithful engineers.

That the want of professional knowledge of the materials, mortars, cements, &c., &c., for construction and repairs, or faithfulness on the part of those charged with the duty, was apparent in nearly all the modern towers and buildings visited by the board.

That the present large sums annually required for renewing, renovating and repairing towers and buildings, are the consequences of the want of an efficient organization, which could afford the necessary professional ability for plans, drawings, and superintending of constructions and repairs.

That the towers are deficient in the necessary proper accommodations for oil and other supplies; in the mode of fitting them up, and in the materials employed for the interior work; and the buildings ill adapted to the comfortable accommodation of the keepers.

That the lanterns are, as a general rule, of improper dimensions, constructed of ill-adapted, and, in the end, not economical materials, without professional or scientific skill; and, in many instances, not suited to the use for which they are designed.

That there is no proper system of ventilation for lanterns.

That the means said to be employed for ventilating are wholly inadequate, and contrary to true scientific principles.

That there is very little attention paid to the painting of the interior of the lanterns and astragals, and in glazing.

That, under a well organized system, the lights, and other aids to navigation, might be greatly increased in number and efficiency, at a large saving upon the present annual cost.

That there has never been an efficient systematic plan of construction, illumination, inspection, and superintendence of lights, &c., &c., in the United States.

That towers and buildings have been constructed without regard to the wants of the service, and to the peculiarities of localities, and the special design of the lights themselves.

That the light-house towers, buildings, and vessels visited by the board were not, in general, found to be in a creditable state of preservation and repair.

That the inferiority of illuminating apparatus in the light-houses of the United States renders its renewal frequently necessary, at great expense, and never produces as effective a light as it is capable of making.

That the reflector apparatus employed in the light-houses of the United States is greatly inferior to the requirements of the service, being defective in form, materials, and finish.

That the illuminating apparatus in the United States is of a description now nearly obsolete throughout all maritime countries, where the best apparatus of that description was employed, prior to the introduction of the Fresnel lenses, as substitutes.

That the sea-coast reflector lights are, in general, too low, and are deficient in power and range.

That our sea-coast reflector lights are not fitted with a sufficient number of lamps and reflectors to produce the greatest amount of usefulness, which the imperfect system of lighting with the reflectors will produce.

That the lamps and reflectors are not, as a general rule, properly placed on the frames, due regard not being paid to divergency.

That the sea-coast lights are deficient in proper attendance, with only one keeper.

That there is no proper classification of lights in the United States.

That the lights are not properly and sufficiently well distinguished along the coast of the United States.

That there is no system of public inspection and superintendence, calculated to render the light-house establishment moderately useful or efficient.

That the lanterns, illuminating apparatus, &c., are not superintended, while they are being made, by competent or faithful professional men.

That there are no general or special regulations for keepers and others connected with light-houses, by which to insure an intelligent or faithful performance of the duties.

That supplies of all kinds, involving the good or bad quality of the lights to a great extent, are not tested and selected by competent persons before issuing them to light-keepers.

That there is not a proper degree of responsibility on the part of the agents connected with the light-house establishment.

That the present mode of procuring and distributing supplies, apparatus, &c., is not calculated to insure either efficiency or economy in the service.

That contractors are not held under a sufficiently rigid superintendence and inspection during the execution of works of construction and repair.

That the modern light-house towers are inferior in point of materials and workmanship to the older ones visited by the board—such, for example, as Sandy Hook light-house, built in 1762; Cape Henlopen tower, built in 1764; Cape Henry tower, built in 1791.

That the floating lights of the United States are comparatively useless for want of efficient lamps and parabolic reflectors.

That the light-vessels are in general not adapted to the service they are required to perform, being defective in size, model, and moorings.

That the light-vessels are not properly distinguished either by day or by night.

That sufficient regard has not been had to the proposed use of the several lights, so as to regulate their power and range accordingly.

That there is no effective system by which to afford to sparsely settled parts of the coasts requiring lights the means of bringing the subject before Congress, and deciding in advance of appropriations the best descriptions of lights to be placed at the desired points.

That many of the small lights have an unnecessary number of lamps and reflectors, while sea-coast lights are greatly deficient in them.

That in the form and adjustment of the reflectors, sufficient attention is not paid to the range and other circumstances of the required lights, involving scientific principles.

That there is not, in useful effect, a single first-class light on the coast of the United States.

That the lights at Navesink (two lenses) and the second order lens light at Sankaty Head, Nantucket, are the best lights on the coast of the United States.

That there are very few, if any, reflector lights on the coast of the United States better in useful effect than the third order lens light (larger model) erected by the Topographical Bureau on Brandywine shoal, while the economy of the lens light is in the ratio of at least 4 to 1.

That the lens lights at Navesink, Sankaty Head, and Brandywine shoal are considered to be, as a general rule, equal to European lights of the same classes.

That the Fresnel lens is greatly superior to any other mode of light-house illumination, and in point of economy is nearly four times as advantageous as the best system of reflectors and Argand lamps.

That the buoys in the waters of the United States are defective in size, shape, and distinction, as a general rule, and that sufficient care is not taken, nor competent persons employed, to place, moor, and replace them.

That the moorings of buoys are not sufficiently heavy, and the chains not properly tested as to size and strength.

That the sea-coast lights along the southern coast from the highlands of Navesink are comparatively useless to the mariner for want of sufficient power and range.

That the dangerous obstructions to navigation around Cape Florida, from the Gulf of Mexico, are not properly lighted and otherwise marked to aid navigators.

That the entire southern coast of the United States requires additional lights and other aids to navigation to render human life and property safe.

That, for want of an efficient organization, there is no systematic plan

adopted on any part of the coast of the United States for rendering navigation safe and easy by means of lights, beacons, buoys, &c., &c.

That lights and other aids to navigation are provided, as a general rule, through the action of Congress upon petitions emanating from persons having a local interest, or from boards of pilots, insurance offices, chambers of commerce, &c.; &c.

That under a proper organization the officers of the light-house establishment would collect information from reliable sources, decide upon the doubtful points, and recommend to Congress all cases of sufficient importance to warrant appropriations.

That the approaches to some of our principal and most important harbors, bays, &c., are not sufficiently lighted and marked to render steam navigation as rapid, easy, and safe as the wants of commerce demand, especially to New York, Delaware, and Chesapeake bays, and some of their tributaries.

That the duty of lighting and marking with beacons, buoys, and sea-marks, our extended sea, lake, gulf, bay, sound, and river coast, efficiently and economically, can only be performed by persons of professional experience and undoubted ability upon a systematic plan, based upon the principles of the most approved light-house engineering.

That there is no efficient system of inspection and superintendence of lights in the United States.

That the light-keepers, in many cases, are not competent, and in no instances have they been instructed in reference to their duties, nor examined to ascertain their ability to perform the duties faithfully.

That the supplies of oil, chimneys, wicks, &c., &c., are not tested and selected with sufficient care, or by competent or faithful agents.

That there is no proper system of distributing the supplies to light-keepers.

That proper attention is not given to purchasing and distributing supplies.

That the cleaning-powder used in our light-houses is injurious to the reflectors, and not such as is used in other light-house establishments; and other articles are equally defective.

That there is no system in the management of the light-house establishment of the United States.

That the instructions to light-keepers to light, trim, and extinguish the lights at certain specified times, are not enforced, to the detriment of the service, and to the imminent risk of endangering vessels in their vicinity.

That such knowledge is not imparted to light-keepers, as a general rule, to enable them to keep their lamps, burners, reflectors and lanterns in such order as to insure the best lights from the existing apparatus.

That frequent and rigid inspections and superintendence by competent persons are necessary to insure an efficient and economical light-house service.

That competent keepers, responsible to the government through inspectors, are indispensable to insure good lights at all times.

That supplies are not delivered at sufficiently short intervals of time to the lights.

That the present mode of repairing illuminating apparatus, oil tanks, &c., is not economical, efficient, or reliable.

That the removal and replacing of light-vessels, the extinguishment or lighting of lights, removal or placing of buoys, &c., or in any manner

changing lights and other aids to navigation, without giving ample notice, are subjects of grave complaint.

That there is no good reason why the light-vessels on the coasts of the United States (if properly constructed and moored) should not remain at their moorings under as unfavorable circumstances as those on the coasts of England and Ireland.

That whenever light-vessels are reported to have parted their moorings, the circumstances attending them should be carefully investigated by competent and disinterested persons, and the result made known.

That the erection of light-house towers of a uniform height, without regard to the elevation of the land upon which they are placed, is contrary to the first principles of light-house engineering, involving, in situations of great natural elevations above the level of the sea, unnecessary expense, and on low coasts the inefficiency of the light for want of sufficient range.

That due regard has not been had to the wants of commerce in selecting sites for lights along the coasts of the United States.

That for want of a proper system in this branch of the public service, the densely populated coasts have a superabundance of lights, to the injury of navigation, while on the sparsely settled coasts, bounding the great outlet to the millions of commerce from the valley of the Mississippi and its tributaries for hundreds of miles, there is not a single light.

That light-house construction, illumination, inspection, and superintendence, involve a large amount of special and general professional knowledge of a high character, and therefore should only be intrusted to the most competent professional persons.

That competent engineers have not been employed, except in a few instances, to plan and superintend the construction and fitting up of the light-houses of the United States.

That the large amounts required annually to repair and keep in good order the towers, buildings, vessels, and illuminating apparatus of the lights in the United States, is attributable to the manner in which the work was executed, and to the inferiority of the materials employed.

That large sums are now required to preserve foundations of light-towers, sea-walls, &c., which might have been saved by the adoption, by competent engineers, of proper plans and foundations for them.

That no systematical and economical plan of construction has been employed in the light-house establishment.

That changes are constantly taking place in the aids to navigation, without any official notice being given to the public of them, which are calculated to mislead mariners.

That there is no proper system of beaconage and buoyage, nor any list by which the navigator, who is not familiar with the coast, can derive any benefit.

That the list of light-houses and light-vessels is defective in many respects; and it, at present, affords very little information to the navigator, and is, in some respects, erroneous.

That there is no regular systematic or effective mode of giving notice to mariners of proposed changes in lights, &c., &c., or of any that may have been destroyed or removed by the action of the sea or winds.

That the buoys are not properly painted according to law, nor are they in other respects properly distinguished one from another.

That light-houses and light-vessels are not sufficiently well distinguished by day.

That the buoys are not properly placed, nor replaced when driven from their positions, and without delay.

That buoys are not placed upon new shoals, over wrecks, &c., except by a special act of Congress, through the agency of some philanthropic or interested person.

That spare buoys are essential for all harbors and rivers in sufficient numbers to allow for all casualties, and for cleaning, painting, &c., &c.

That there is no code or manual of instructions to guide light-keepers and others connected with the light-house service, in the performance of their duties, in this country, as is found in every well regulated light-house establishment elsewhere.

That there is no meteorological reason for the lights of the United States being worse than those of equal class and importance in England and France.

That there are no proper books of daily expenditure kept; no returns of daily expenditure made of a reliable character; and the lights are deficient in all the essentials for the faithful performance of this duty, such as books, forms, registers, &c., &c.

That light-keepers should be required to devote all their time to the care of the lights under their charge, and should not be allowed to attend to their ordinary affairs to the injury of the service.

That if all our present lights were fitted with lens apparatus of equal power to the reflectors now in use, the annual expense for supplies of oil and cleaning materials would cost little more than one-fourth as much as is now expended for these articles of supply annually; that is, that the supplies now costing upwards of \$152,000, would not exceed \$38,000 to \$42,000, making an annual saving of \$110,000 to \$115,000.

That in addition to the greater superiority in brilliancy, power, and economy of the lenses, compared to the reflectors, they possess the great advantage of durability, to the extent of never requiring to be renewed.

The board, therefore, recommend—

That the general programme for improving the sea-coast lights of the United States, and of making necessary additions, be adopted as the basis of future recommendation and legislation.

That the Fresnel, or lens system, modified in special cases by the holo-photal apparatus of Mr. Thomas Stevenson, be adopted as the illuminating apparatus for the lights of the United States, to embrace all new lights now or hereafter authorized, and all lights requiring to be renovated either by reason of deficient power or of defective apparatus.

That the board respectfully recommend to the honorable Secretary of the Treasury to direct that, pending the future action of Congress on the subject of light-house improvements, the seventh section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851, in the following words:

“SEC. 7. *And be it further enacted*, That hereafter, in all new light-houses, in all light-houses requiring new lighting apparatus, and in all light-houses as yet unsupplied with illuminating apparatus, the lens, or Fresnel system, shall be adopted, if in the opinion of the Secretary of the Treasury the public interest will be subserved thereby,”—be strictly carried out, and

that the necessary illuminating apparatus to fit up the light-houses now authorized to be built shall be of the lens system.

That a rigid and frequent inspection and superintendence by competent persons is essential to an efficient light-house establishment, and the board, therefore, recommend the appointment from the army and navy of a suitable number of inspectors for the lights and their accessories, throughout the United States.

That the present light-house establishment requires a thorough organization to insure to the service efficiency and economy; and therefore the board recommend the organization of a light-house board, to be composed of scientific civilians, army and navy officers, to be charged, by law, with the entire management of the light-house establishment of the United States.

That all sea-coast and other first-class lights should have not less than two keepers, including all first and second order lens lights.

That all constructions, renovations, and repairs of towers and buildings, be hereafter made upon the plans, estimates, and drawings, and under the personal superintendence of an officer of engineers of the army, in conformity to the ninth section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851.

That the lanterns, and all apparatus for illumination, ventilation, &c., be constructed under the personal superintendence of an officer of engineers of the army.

That the sea-coast lights be increased in power and range.

That all light-vessels not yet fitted with illuminating apparatus, requiring to be renovated, and all that may hereafter be authorized by law, be fitted with the best system of lamps and parabolic reflectors, both for fixed and revolving lights.

That more attention be given to the subject of models for light-vessels, constructing and mooring them, so as to give greater assurance to the navigator that they will be always found in position.

That light-vessels be painted and fitted with distinguishing marks by day, to enable the mariner to know them without difficulty.

That there be a uniformity in painting, marking, and distinguishing beacons; and that no one be allowed to change the color or distinguishing marks of any beacon, sea-mark, or light-house, without authority from the proper office at Washington, and after ample notice shall have been given through the medium of the commercial papers of greatest circulation, and by placards distributed at the different custom-houses, both at home and abroad, and among consuls and commercial agents of maritime nations.

That the buoys be made in size to subserve their proposed purpose, and that different shapes be employed for different channels, dangers, &c., &c.

That competent professional men be required to make frequent inspections of the lights and other aids to navigation along the entire coast.

That supplies of all kinds undergo a most rigid test and scrutiny by a professional person of high moral and social standing, before issuing them to light-keepers.

That light-keepers undergo an examination before being placed in charge of any light, and that they be instructed by a competent person upon the detail of all the duties confided to them.

That instructions, rules, and regulations, embracing every point of duty, be drawn up in clear, plain, and explicit terms, suited to the capacities of the persons for whose benefit they are prepared, and distributed to the

light-keepers and others connected with the service ; that the general rules and regulations be printed in large type, with conspicuous headings, and framed, so that the keepers may always have access to them ; and those more in detail to be well bound, and the keepers required to transfer them to their successors should they leave the lights.

That frequent and rigid inspections of lights by districts be made by competent professional men, and that they make regular returns to the head of the light-house department.

That the keepers be required to keep meteorological and tidal registers, in addition to the necessary returns of the daily consumption of oil and other supplies.

That no light-house keeper be appointed who cannot read and write, and is not in other respects competent to the faithful discharge of the duties.

That a mode of supplying persons employed at lights on rocks or other isolated points, on board of light-vessels, &c., &c., with rations, to enable them to devote their entire time and attention to the duties, should be adopted.

That light-keepers be required to devote their entire time and attention to their duties on pain of dismissal, and in no case should a keeper be allowed to follow any other vocation to the neglect of the light.

That no keeper be allowed to be absent from the light without a positive written permission from the district inspector.

That no one but a regularly appointed keeper, and his assistant or assistants, be permitted to attend to the apparatus, lighting, &c., &c., of a light-house or light-vessel.

That the best cleaning powders, rags, &c., trimming scissors, and other necessary articles for keeping good lights, be furnished to the keepers ; and that they be instructed that, under no pretext, should they employ any other means for keeping their apparatus in good order than those pointed out in the printed instructions from the department.

That proper curtains be provided for the apparatus of each light-house, &c.

That light-vessels never be removed from their stations for repair without first placing a substitute ; and in the event of a light-vessel parting her moorings, then that position be occupied without delay by a substitute.

That proper lists for the supply of each class of light-house, according to order or number of lamps, be made, and the person charged with the delivery of supplies be guided by it alone, without any discretionary power to increase, lessen, or change the quantity of articles to be on hand on a certain day.

That all the articles of supplies be selected and tested by persons of professional ability and standing.

That the necessary steps be taken, without delay, to ascertain what additional aids to navigation are necessary in the bays of New York, Delaware, and Chesapeake, and their tributaries, to enable steamers and other vessels to enter them at night, and proceed direct to their destination.

That hereafter, buoys required to be placed over newly discovered shoals, or over vessels wrecked in or near channels, or where they may endanger vessels, be placed without delay, and the expense be defrayed from the general appropriations for buoys.

That larger and better distinguished buoys be placed to mark the chan-

nels of our principal bays and harbors, especially New York bar and bay, Delaware and Chesapeake bays, &c.

That appropriations be asked for two first-class light-vessels, to be fitted up in the best manner with the most approved reflector or refractor apparatus, and with proper distinguishing characteristics—one for the South shoals off Nantucket; and the other for Frying-Pan shoals, off Cape Fear—to be placed in the best positions for aiding navigators, under the direction of the Superintendent of the Coast Survey.

That appropriations be asked for renovating, and for first order lens apparatus, for the lights at

Cape Hatteras, North Carolina;
Cape Florida, Florida;
Dry Tortugas, Florida;
Cape Canaveral, Florida;
Cape Romain, South Carolina;
Fire-Island inlet, New York;
Cape Henlopen, Delaware;
Cape Henry, Virginia;
Gay Head, Massachusetts;
Montauk Point, New York;

and for the following new lights, to be fitted with first order lenses, viz:

One, half way between Montauk Point and Fire-Island light-house, Long Island; and one between Jupiter inlet and Gilbert's bar, Florida.

That the appropriation for Flynn's Knoll light-house be changed to authorize range beacons for New York harbor.

That an appropriation be asked for a bell-beacon for Flynn's Knoll.

That, as the foregoing recommendations can only be thoroughly carried out under the orders of a properly organized bureau or board; and as it is of vital importance to the interests of commerce and navigation, and of great importance, in an economical point of view, that the present light-house establishment should be improved as rapidly as possible; to carry out these suggestions, it is further recommended:

That a light-house board be created, by authority of law, to be attached to the Treasury Department, with power to provide rules and regulations for their meetings and proceedings, and for discharging, under the superintendence of the Secretary of the Treasury, all the duties appertaining to the management, maintenance, repair, renovation, illumination, inspection, superintendence, and construction of light-houses, light-vessels, beacons, buoys, and their appendages, in the United States.

That the Secretary of the Treasury, as ex officio president, with two officers of the navy of high rank; one officer of the corps of engineers of the army; one officer of the corps of topographical engineers of the army; and two civilians, of high scientific attainments, whose services may be at the disposal of the President, as members; and an officer of the navy, and an officer of engineers of the army, as secretaries, shall constitute the light-house board of the United States.

That the light-house board be authorized to appoint their chairman, to preside during the absence of the president, and perform such other duties as may be required by their rules and regulations.

That the light-house board be authorized to prepare such rules and regulations as shall be necessary for securing an efficient, uniform, and economical system of light-house administration, and for securing responsibility

in the inspectors, keepers, and others connected with the light-house service, subject to the approval of the Secretary of the Treasury, and which, when approved, shall be respected and obeyed, until altered or revoked by the same authority.

That the light-house board be required to meet four times a year, and subject to be convened by the Secretary of the Treasury, whenever, in his judgment, it may be necessary for the transaction of general or special business; a majority of whom shall constitute a quorum.

That such clerks as are now employed on light-house duties in the Treasury Department may be transferred to the light-house board, without any increase of salaries; that the necessary accommodations for the clerks, secretaries, for the preservation of the archives, drawings, &c., &c., and for holding the meetings of the board, be provided in the Treasury Department.

That all archives, books, drawings, models, &c., &c., belonging to the light-house establishment, may be transferred to the light-house board, for their use, in the discharge of their duties.

That the President be authorized and required to appoint, from the army or navy, an inspector of lights, beacons, buoys, &c., for each light-house district, to be arranged by the board, with the approval of the Secretary of the Treasury; which inspectors shall be under the orders of the light-house board.

That the light-house board be authorized to prepare and distribute among the light-house keepers, inspectors, and others connected with the light-house establishment, such rules, regulations, and instructions, as may be necessary to secure an efficient, uniform, and economical system of administering the light-house establishment of the United States, and to secure responsibility from them.

That the light-house board be authorized and required to cause to be prepared by the engineer-secretary of the board, or by such officer of engineers of the army as may be detailed for that service, all plans, drawings, specifications, and estimates of cost, of all illuminating and other apparatus, and of construction and repair of towers and buildings, &c., &c., connected with the light-house establishment; no bids or contract being accepted or entered into, except upon the decision of the board, at a regular or special meeting, and through their properly authorized officer.

That, hereafter, all materials for the construction and repair of light-houses, light-vessels, beacons, buoys, &c., shall be procured by public contracts, under such regulations as the board may from time to time adopt, subject to the approval of the Secretary of the Treasury, and all works of construction, renovation, and repair, shall be made by the orders of the board, under the immediate superintendence of their engineer-secretary, or of such engineer of the army as may be detailed for that service.

That it shall be the duty of the light-house board to furnish, upon the requisition of the Secretary of the Treasury, all the estimates of expense which the several branches of the light-house service may require, and such other information as may be required, to be laid before Congress at the commencement of each session.

That all acts and parts of acts inconsistent with these recommendations, be repealed; and all acts and parts of acts relating to the light-house establishment of the United States, not inconsistent with these recommendations, and necessary to enable the light-house board, under the superin-

tendence of the Secretary of the Treasury, to perform all duties relating to the management, construction, illumination, inspection, and superintendence of light-houses, light-vessels, beacons, buoys, sea-marks, and their accessories, including the procuring and testing of apparatus, supplies, and materials of all kinds for illuminating, building, and rebuilding when necessary, maintaining, and keeping in good repair the light-houses, light-vessels, buoys, beacons, and sea-marks of the United States; and the second and third sections of the act making appropriations for light-houses, light-vessels, beacons, buoys, &c., approved March 3, 1851, be declared to be in full force, and have the same effect as though the light-house board had not been created.

That no additional salary be allowed to any civil, military, or naval officer who shall be employed on the light-house board, or who may be in any manner attached to the light-house service of the United States; and that it shall be unlawful for any member of the light-house board, inspector, light-keeper, or other person in any manner connected with the light-house service, to be engaged, either directly or indirectly, in any contract for labor, materials, or supplies for the light-house service, or to possess, either as principal or agent, any pecuniary interest in any patent, plan, or mode of construction or illumination, or in any article of supply for the light-house service.

With such a board for the care and management of our present large and daily increasing light-house establishment, composed of the best adapted materials, from civil, military, and naval life, our lights must not only rapidly improve in efficiency, but also in economy.

By the assistance of the officers proposed as inspectors, and the two secretaries of the board, a general and systematic plan of classification, distinction, illumination, construction, repair, inspection, and superintendence, will, in a short time, be introduced, to the great advantage of commerce and navigation, and to the economy of the service.

The engineer secretary, with the assistance of officers of engineers now authorized by law to superintend the construction and renovation of light-houses, &c., will be able to prepare plans, estimates, and specifications of proposed works of construction and repair, and give a general superintendence to the lights, beacons and buoys along the entire coast. The board will be able, at the close of the first fiscal year after it is in operation, to make detailed returns of expense of apparatus, combustibles, &c., &c., exhibiting at one view the actual annual expense of every light on the entire coast; examine into the best modes of construction for special positions; make necessary experiments upon apparatus, oils, gases, &c., &c., for light-house purposes; and determine, from information derived from their own and other competent officers, what increased aids are necessary along the coast to recommend to Congress.

They would in a short time be able to furnish to navigators clear and full descriptive lists of the lights, beacons, buoys, sea-marks, &c., with such notices of them as may be necessary to guide them in making our coast in tempestuous weather, and which could be reprinted at short intervals of time, if necessary, to point out new structures or changes.

The coast survey charts would then be furnished with an account of every change of position or character of lights, buoys, beacons, &c., &c., which would enhance their present great value to the navigating community.

Under an efficient organization, such as the one proposed, the duty would

be performed better and more economically than at present; and there would be great saving in the end, by affording to Congress estimates for proposed new works, rejecting works not considered necessary, and by introducing a class of structures which would require much less annual expense for repair than those now existing.

The ablest engineers of the army would be called upon to decide upon plans for structures in cases involving doubts; the best and most durable illuminating apparatus would either be imported or fabricated in this country under the immediate eye of the officers of the board, and, when ready, be placed properly in the lanterns by the engineer charged with the work.

Boards for the execution of important duties are not novelties even in this country. Some, and indeed nearly all, of the most important undertakings which this government has ever embarked in, have been planned and executed under the general supervision and management of boards.

They are found in nearly every branch of our civil and military institutions; of every name, and for almost every purpose. They have been successfully tried for this special purpose in France, where the Savans of the academy of sciences, without fee or reward, sit side by side with the minister of state, the officer of the navy, and the engineer. In England, the Duke of Wellington presides, while the prince, the peer, the admiral, the commoner, and the retired sea-captain, sit together and devise means for alleviating the hardships and lessening the dangers of the mariner in approaching their dangerous coast.

In Scotland this important branch of service is under the management of a board composed of the sheriffs of the counties, lawyers, and other civilians, who meet four times a year, without any remuneration, to transact business connected with the lights of Scotland.

In addition to these meetings there are numerous standing committees; some of which meet as often as once a fortnight for the transaction of business, which is reported to the general meetings for their sanction and approval. There is attached to this board a secretary and an engineer, who is the executive officer, upon whom devolve all the scientific details of construction, repairs, and illumination.

In Ireland there is also a board charged with the management of light-houses, &c., with a secretary, engineer, &c.

This board, as in Scotland, is composed chiefly of philanthropic civilians and an English admiral. The fact of Scotland and Ireland having no army or navy, and no distinct commercial marine, will readily account for such an organization, in which no motive, other than the praiseworthy one of doing good, could prompt individuals of standing, wealth, and distinction to perform the drudgery of so laborious an office without pecuniary remuneration.

There is not a harbor in England, of any note, that has not its "Trinity board," or "board of trustees," charged with the lights, beacons, and buoys; such, for example, as Liverpool, Newcastle-upon-Tyne, Hull, &c., under all of which the lights are managed in a manner worthy of the highest commendation, both for efficiency and economy. (Vide letter of Wm. Lord, esq., surveyor of the port of Liverpool, and returns of local corporations, appendix.)

It is thus seen that the best managed lights of Europe are under the management and direction of boards, with proper officers to assist them in their duties. That this service should be deemed sufficiently honorable in France,

Scotland, &c., to be performed gratuitously, is not so much to be wondered at, when we recollect the high standard of excellence it has reached through the instrumentality of the philanthropic individuals constituting those light-house boards.

In concluding this part of their report, the board consider it their duty to urge upon Congress the necessity for a change in the present management of our light-house establishment.

In investigating the subjects confided to them, they have endeavored to reach the truth from observation and research. That they have not done injustice to any one, they feel perfectly conscious; to have passed over palpable defects in the present management of our lights, involving great loss of human life and property, without pointing them out, would have been culpable and unpardonable; and that they have looked as leniently as possible on many points considered exceptionable, it is believed will be clearly shown by their report.

The board have not sought so much to discover defects and point them out, as to show the necessity for a better system. Commerce and navigation, in which every citizen of this nation is interested, either directly or indirectly, claim it; the weather-beaten sailor asks it, and humanity demands it.

GENERAL CONDITION OF THE LIGHT-HOUSES, &c., OF THE UNITED STATES.

1. To ascertain the general condition of the lights of the United States, the board adopted several modes:

First, to visit a sufficient number of light-houses and light-vessels on different points of the coast, and to ascertain their condition by actual examination, and by inquiring of those employed in them.

Secondly, to make inquiries of intelligent nautical men commanding United States mail and other sea-steamers, packets, and other sailing ships, making over-sea voyages, chiefly between American and European ports, civilians, and officers of the navy.

Thirdly, by inquiries addressed to the general superintendent of lights, and to local superintendents, to ascertain the views and principles upon which the action of the general system and its local arrangements were based.

2. It was soon apparent to the board, that any extended detailed inspection of lights, &c., would be a waste of time and money, and that it was only necessary to examine such lights as were characteristic and afforded the best specimens of the several kinds, such as the Boston light, fitted with reflectors made in London; the lens lights at Navesink, N. J., San-katy Head, Nantucket; and the gas light at Reedy island, Delaware bay; or such as, from the importance of their position, should be types of the class to which they belonged; as Cape Elizabeth, Maine; Isle of Shoals, off Portsmouth, New Hampshire; Sandy Hook, New Jersey; Cape Henlopen, Delaware; and Cape Henry, Virginia, for sea-coast lights: Portland, Portsmouth, Boston, New Bedford, New York, Baltimore, and Old Point Comfort, for harbor lights, and such as would show any differences due to locality on the different parts of the coast.

3. A set of questions (see appendix A) was prepared, and a list of points upon which information was required, was made, so as to embrace the facts

desired to be ascertained in these inspections. The results are given in the notes in the appendix A, No. 2, &c.

In reference to the condition of the lights, &c., visited, the following is submitted by the board, as embracing a general view of them :

Lens or Fresnel apparatus.

The first point visited by the light-house board for inspection and examination, was the two lights on the highlands of Navesink, New Jersey.

As the lights at Navesink—the second order lens light recently lighted at Sankaty Head, Nantucket, and the third order lens at Brandywine shoal—are the only lens lights on the coast of the United States, they will be referred to, and reported upon, without regard to the time the visits were made.

Lights at the Highlands of Navesink, New Jersey.

There are two towers at this station, having an elevation above the level of the sea of about 250 feet—one fitted with a first order catadioptric fixed apparatus, and the other with a second order revolving catadioptric apparatus. The apparatus employed in these two towers was constructed by M. Henry Le Paute, in Paris, by order, and under the superintendence of Commodore Perry, United States navy, who was directed by the government to purchase apparatus constructed on the principle of M. Fresnel, in obedience to a special act of Congress appropriating the necessary funds for the object, approved July 7, 1838.

These towers were elevated and otherwise improved to receive this apparatus, with the view, as it was understood, to test the alleged superiority of this mode of illumination to that employed in the light-houses along the entire coast of the United States.

A first order fixed lens light was thus placed by the side of a second order revolving lens light, with the view to distinction, disregarding the relative powers of the two sets of apparatus.

Although this apparatus, at the time it was constructed and received, was of the most approved description, and equal to the best in Europe, subsequent improvements have rendered it inferior to the illuminating apparatus of the same orders employed in recently erected or recently renovated towers in those countries, especially in those of France, England, Scotland, and Ireland; yet, at the present time, the Navesink lights are justly esteemed by intelligent navigators and others, who have compared them, as the best lights on the coast of the United States.

The mirrors, constituting a most essential portion of the apparatus in these towers, are, with very few exceptions, out of adjustment, and otherwise greatly neglected, to the serious injury of the lights in brilliancy and power. Neither the refractors nor mirrors have received that attention and care which an intelligent and properly instructed keeper would have insured to them.

The keeper has no knowledge of the mode by which the apparatus can be adjusted, nor is there any competent person employed to perform that important service; nor is there any one charged with the repair of the mechanical lamps and machinery for the revolving light.

The principal keeper, without having had any instruction or previous

knowledge of the machinery to enable him to perform faithfully these important duties, endeavors to do so, but is wholly unable to adjust the mirrors and keep the machinery for the revolving light in proper order.

The present principal keeper of these lights entered upon his duties about two years since, without having been previously subjected to any examination to test his ability to perform the duties, or his fitness for so important a trust. Four assistants are allowed to these two lights; those found at the station by the present keeper remained with him until he thought proper to dismiss them, which he did, and appointed their successors, without consultation with, or the approval of, any one.

A small printed work, purporting to be a translation of the instructions to the light-keepers in France, and the printed letter from the office of the Fifth Auditor, directing the keeper to light his lights at sunset, and extinguish them at sunrise, and to keep a bright, clear light, during the night, &c., are the only guides in the possession of the keeper to the performance of his duties.

The lights are not lighted at sunset, but at dark; and are not kept burning until sunrise, but are extinguished at daylight. The reason assigned by the keeper for not obeying his printed instructions was, that he had received verbal instructions from the person sent from the custom-house at New York, not to do so. The lamps are not trimmed during the night, except when compelled to burn bad oil.

The principal keeper does not keep a watch during the night, but divides the four assistants into two watches, two for each tower, and alternating in their duties—the first watch being from the time of lighting until midnight, and the second watch from midnight until daylight. The principal keeper generally retires to bed at nine o'clock, and is only called when something goes wrong.

There are but two spare lamps for these two lights, which are kept in the workshop, at a distance of some forty yards from the towers. There is no spare lamp, filled and ready for immediate use. The keeper thinks he could replace a lamp, in the event of an accident, in half an hour. In all other countries where lens lights are employed, a spare lamp is kept always at hand in the trimming-room, trimmed and filled, requiring only a few minutes to change them, and each light is supplied with two spare lamps.

These lights have never gone out at night, so far as the present keeper knows; nor has he found any difficulty in keeping the lights burning.

The lanterns of these towers (more especially that of the revolving light) are too contracted to allow the attendants upon the lights to perform their duties to advantage. Several panes of glass were found broken, and the keeper was without the means of replacing them.

The establishment was found to be in tolerably good order, having been very recently painted in every part, including the steps and floors. The interior of the dome of the lantern is painted red, instead of white.

The two towers are very badly constructed of rubble stone, and their present condition is very bad, owing to leaks and cracks. There is no cellar for oil, nor storerooms in the towers for wicks, chimneys, cleaning-cloths, &c. The oil is kept on the ground-floor of the towers, where the temperature is necessarily very variable.

The annual consumption of oil, of these two lights, is nine hundred and thirty-six gallons; equal to about the consumption of one light, fitted with parabolic reflectors, and twenty-four lamps—the nearest approximation that

can be made, in point of useful and economical effect, brilliancy, and power, to the revolving light. The winter oil is generally bad, but sometimes is good. The person charged with the delivery of oil, and other light-house supplies, uses his own pleasure and discretion in delivering the articles, as regards quality and quantity; requiring the keeper to sign receipts made out by himself. The keeper has never used winter oil in the summer, but is satisfied that the winter oil makes the better light, when of good quality, from the wicks being less charred when that oil is used.

The chimneys to the carcel lamps are not of proper size and shape. The ventilation-holes in the lanterns are fitted in a manner not calculated to fulfil perfectly their object. The door of the light-room is required to be left open in the winter, the smoke from the stove being insufferable when it is shut; which has a deleterious effect upon the flame of the lamp. There are no proper means employed for warming the oil in cold weather.

There is no alarum fitted to the lamp, to apprize the keeper of any accident or obstruction to the proper flow of oil to the wick—a most necessary appendage, even when the attendant keeper is always in the tower.

No journal, or daily expenditure of oil and other supplies, nor is there a meteorological or other book, kept.

The dwellings and out-buildings are all out of order, and require repairs.

The lights on Navesink were compared with the Sandy Hook light, and with each other, from the deck of the light-vessel, moored at a distance of six to seven miles from the two stations. In making these comparisons, colored glasses of different shades were used, besides ship's glasses, to aid the eye in judging of the relative powers of the lights. While the two lens lights were found to be greatly superior in brilliancy to the Sandy Hook light, it was equally apparent that the second order revolving light was more brilliant than the first order fixed one. The Sandy Hook light, fitted with eighteen twenty-one-inch reflectors, was decided to be nearly equal in intensity, when one and a quarter mile (estimated) from East Beacon, to the revolving Navesink light; making the distance from the observer to the Sandy Hook light two and a quarter miles, and the Navesink light five and seven-eighth miles; at the same time, the Sandy Hook light was *orange color*, and the Navesink lens lights *white*. That is to say, *the relative useful effect of the Navesink and Sandy Hook lights is in the proportion of 5.2 to 1; or, the Navesink lights are 5.2 more powerful and effective than the Sandy Hook light.* The economical effect cannot be stated with so much accuracy, in consequence of there being two lights at Navesink of different orders.

The estimated consumption of oil of the first order
lens, is ----- 570 gallons.

Do. of the second order lens, is ----- 384 “

Total, per annum ----- 954 “

Reported consumption, including oil required in the
dwelling of the keeper and assistants ----- 936 “

The estimated annual consumption of oil in the
Sandy Hook light, is ----- 720 “

Reported consumption ----- 661 “

Taking the consumption of the smaller lens, which was shown to be more brilliant than the first order fixed lens, and we shall have the economical effect in the proportion of 1.72 to 1 ; or, *the reflector light is one and three quarter times more expensive, for oil alone, than the lens light.*

The equality in point of brilliancy of the Sandy Hook light (which is not inferior to any reflector light on the coast) and the Navesink lens light, at the respective distances of two and a quarter miles from Sandy Hook, and five and seven-eighth miles from Navesink, furnishes an unanswerable argument in favor of the lens system, independently of the great economy of oil, wicks, &c., in the use of the lens, when properly kept.

There are too many keepers allowed to these two towers—one principal and four assistants ! Taking into consideration the contiguity of the two towers, one principal and two assistants ought to be sufficient to perform all the duties properly and efficiently.

In that case the three keepers should be required to take regular alternate watches, changing them every night ; making but four hours per night for each keeper, who could visit each lantern by turns, and perform all the duties of the light-room with ease, and be ready in the morning to assist in cleaning the apparatus, and keep the lantern-panes of glass, during snow, sleet, rain, &c., clean and dry .Should it be deemed necessary, however, to have more keepers than three, four, including the principal one, would be a large number for the amount of labor required to be performed.

Under no circumstances should the principal or any other keeper be exempted from keeping a regular watch ; and under no circumstances, except in the event of there being only three keepers for the two contiguous towers, should the lantern be left without a keeper from the time of lighting in the evening to extinguishing in the morning.

The authority to remove and appoint assistant keepers should not rest with the principal, but with those who would have every inducement to select the best and most capable persons.

Neither keepers nor assistants should be appointed to fill so important a trust without previous instruction in the duties, and having shown themselves, by a rigid examination, in other respects well qualified for the trust. While the assistants should be under the orders and direction of the keeper, they should not hold their offices at his mere will, but upon the decision of proper persons, after fair examination into complaints of incompetency or malpractices, made of them by the principal keeper. The principal keeper, being held responsible for the faithful performance of the duties, the care and responsibility of all supplies, and the general charge of the establishment, should have under his control, assistants who are not only disposed to perform the duties faithfully, but be in every respect qualified to execute his orders, under the instructions from the Treasury Department. To leave the appointment and dismissal of assistants wholly in his hands, might, and doubtless would in some cases, be productive of injury to the service, and if not entirely, to some extent, defeat the wise and beneficent objects of establishing and keeping up at great expense these essential means of saving human life and the property of our citizens.

The burners to the mechanical lamps belonging to these lights are made of tin, and require to be repaired about once in three months. A burner tipped with silver, which would more effectually resist the action of the great heat evolved, would prove to be much more economical, and insure a more certain and steady light.

The principal keeper to these lights received the board very civilly, and answered all the questions propounded to him, promptly; evinced a great desire to gain information relating to his duties, but seemed to regret that he had not had the means of acquiring the necessary information. Under these disadvantages, he deserves great credit for keeping so good a light as he does.

Sankaty Head light, island of Nantucket.

This is a second order, movable (flashes in one and a half and three minutes, according to the printed list) lens or Fresnel light. The apparatus is octagonal, placed in a lantern of iron on a cast-iron pedestal, about fifty-seven feet from the surface of the ground to the focal plane. This apparatus was constructed in Paris by M. Henry Lepaute, under the direction of Mr. Isherwood, in conformity to the fifth section of the act of Congress, approved August 14, 1848, making appropriations for light-houses, &c., which provided six thousand dollars "to purchase lenses, and to fit up, under the direction of the Secretary of the Treasury, a light-house, to make trial of Mr. Isherwood's plan of discriminating one light from another, and of determining the distance of a vessel from a light."

The tower is placed on an elevated point of the island of Nantucket, known as *Sankaty Head*, the appropriation for which having been made by the act of Congress approved August 14, 1848, upon the recommendation of the Superintendent of the Coast Survey, based upon the then recent discovery of new shoals by Lieutenant Commanding Charles H. Davis, United States navy, and his report of November, 1847, strongly recommending it both for the general as well as local wants of navigation. It is justly esteemed by those navigating around and about the Nantucket shoals, and by those making European voyages, as one of the most important aids to navigation on the coast of the United States.

This apparatus differs from other lenses of the same order, in being divided in its focal plane by a metallic frame, for the alleged purpose of enabling the designer to transmit, at will, the rays of light emitted, to any desired angle, either below or above the horizontal plane. At the time the board visited the light, the experiment was not undergoing test; but so far as observation allowed them to decide, it was adjusted to transmit to the horizon of its greatest range all the rays of light of which it is capable.

Notwithstanding the division by the metallic frame in the focal plane, this lens is acknowledged universally, so far as could be ascertained, to be, if not the best light in point of brilliancy and power, greatly superior to all others (except, perhaps, those on the highlands of Navesink, New Jersey,) on the entire coast of the United States. (See letters in appendix from collector at Nantucket, &c., &c., &c.)

The present principal light-keeper in charge of this establishment is a most respectable and intelligent retired sea captain, who commanded a merchant ship for twenty-five years, and who knows the importance of his trust, and evinces a most praiseworthy interest in the performance of all his duties.

He is assisted by two persons, who, for want of quarters at the light-house, are compelled to reside at some distance from it, to the detriment of the service.

The present keeper took charge of the light on the night it was first

lighted, (February 1, 1850,) without previous knowledge or instruction as to its management, but encountered no other difficulty in managing the mechanical or carcel lamp than that arising from the use of bad oil, which he has frequently had.

A regular account of the oil consumed each night is kept. There is but one spare lamp, which is always kept filled and trimmed ready for use in the light-room, and which, in the event of an accident to the other, could be put in place and lighted in fifteen minutes' time.

There are three spare burners kept ready to supply the place of those requiring repairs.

Extra cords are provided for movable machinery. The lens makes one entire revolution in eight minutes.

The journal of expenditure of oil shows the following :

Received July 24, 1850 -----	253 gallons "summer oil."
Received July 24, 1850 -----	204 gallons "winter oil."

Total quantity received-----	457 gallons.
On hand July 1, 1851-----	87

Balance ----- 370 gallons ;
being the total quantity consumed from the 24th July, 1850, to July 1, 1851—eleven months and seven days; or 395 gallons consumed per annum—about the quantity of oil required for a small beacon-light in any of our rivers and harbors, fitted with ten lamps and reflectors; it having been satisfactorily ascertained by Mr. Alan Stevenson, the distinguished engineer who is charged with the care and management of the Scotch light-houses, &c., and by others who have devoted their time and talents to lighthouse improvements, that forty gallons of oil is the annual average consumption per lamp with reflectors, when the flame is kept at its normal height. The estimated consumption in this country is thirty-five gallons per lamp; but the report to the Secretary of the Treasury (Ex. Doc. No. 14, December, 1850) shows that the consumption of oil varies too greatly in different establishments to afford reliable data from which to determine the average consumption.

The principal light-keeper at this station has no other instructions to guide him in the performance of his duties, than those written out for him by the officer who superintended the placing of the apparatus. He has no instructions for the government of his assistants, who consequently feel independent of him and his orders, which produce difficulties. The two assistants and the keeper take a regular watch during the night, relieving each other every four hours. The establishment was found to be clean, and in every respect in good order.

In other countries, a light of this class, placed as it is, would have only one assistant keeper, who, with the principal, would keep a regular watch, alternating each night from sunset to midnight, and from midnight to sunrise; and it is believed *that number* would suffice for all the wants of the establishment, if placed in the hands of thoroughly instructed and trained keepers.

Seamen in our ships keep watch and watch, besides remaining on deck to perform all the duties at sea during the day, exposed to all the vicissitudes of sea-life; the light-keepers, on the contrary, have very little to do during the day, under a proper system for a fair distribution of labor, and at night

are not exposed to the weather, except occasionally, to keep the glass of the lanterns free from sleet and snow, or from dampness, which may in a great degree be prevented by keeping the interior of the lantern properly ventilated.

The tower was completed in 1850, having been constructed by contract, under the supervision of the collector at Nantucket. It is well built of hard brick laid in cement, from five feet below the surface of the earth to an elevation of fifty-three feet, to which is added six feet of granite, upon which a lantern, nine feet in elevation, is placed, having a cast-iron spiral staircase and floors.

There seems to be an anomaly in making the foundation of brick, while granite is used in completing the tower to the floor of the lantern.

The interior of the lantern is painted white, but leaks, to the great injury of the apparatus. The astragals are vertical instead of being diagonal, as they should be, with plate-glass, 54 inches by 28 inches, and $\frac{7}{16}$ of an inch in thickness.

There was a large plate of red glass, which the keeper stated was intended for one side of the octagon, (the remaining seven not having been received) to show red flashes from the lower portion of the lens, to be seen at a distance not exceeding seven miles. Whether this experiment has been tried, or how far it has been successful, is not known.

The keeper to this light is a man of far greater intelligence than the light-keepers generally in this and other countries, but the successful manner in which he has managed it, without previous instruction, goes far to prove the necessity for employing just such persons in all of our seacoast lights.

Brandywine Shoal light, Delaware bay.

This is a light-tower, erected upon iron screw-piles for a foundation, under the direction and management of Major Hartman Bache, of the corps of United States topographical engineers.

The reports of the chief of the Topographical Bureau will afford all the detailed information in relation to the progress of this difficult undertaking, from its earliest stage to its final successful completion, on one of the most difficult sites that could have been selected.

This tower is illuminated by a beautiful specimen of a third order larger model lens, or Fresnel apparatus, constructed by M. Henry Lepaute, of Paris, on the most approved plan. The burner is composed of two concentric wicks, the interior one being two inches in diameter. This beautiful specimen of mechanism was found to be in fine order and well cared for; it was impossible to detect a single scratch or fracture in any part of the apparatus, which is entirely free of imperfect prisms.

The principal keeper, at the time of the visit of the board, took charge of the light on the 28th October, 1850, (the night on which it was first lighted) without having had the advantage of previous instruction in the management of the carcel lamp, and found difficulty in keeping a brilliant and powerful light at first, but has none now.

Three persons are allowed to assist the keeper in charge of this establishment, more especially to enable him to communicate by boat with the shore and with the pilot-boats, which frequently approach the light, to aid him in getting provisions, &c. With a proper system of visitation and

superintendence, the number of persons attached to this isolated position might be lessened, without detriment to the service; but so long as keepers are compelled to provide themselves with rations, for a position so difficult of approach for a great portion of the year as this is, (it happening very often that all communication is cut off for weeks at a time from the shore) it will be necessary to keep a boat's crew stationed at this light.

The keeper, with his assistants, keeps a regular watch during the night; in addition to which, he repairs the lamps, fits new valves, &c., &c., as required.

The lantern is fitted with thick, clear French plate, glass 30 + 32 inches, and the interior painted white.

Regular reports are made to Major Bache, (who has charge of the work) of changes in the bottom under the structure, and of the consumption of oil, other supplies, &c.

The consumption of oil has been found, by careful observation, to be an average of 1.19 gill per hour.

This establishment is furnished with all the necessary tools and appliances for repairing the lamps, a barometer, and thermometer, a clock, water-filter, and medicine chest.

A meteorological journal is kept.

A fog-bell weighing 500 pounds, with a hammer of 14 pounds, is attached to this light, which is struck by a clock-work movement. The bell in foggy weather is struck seven times in thirty seconds, then an interval of thirty seconds before it is struck again; which serves as an admirable means of distinction, in a vicinity where there are other fog-bells.

This establishment has been fitted up with the greatest care, and contains every conceivable requisite, embracing a water-tank of iron, capable of holding 1,050 gallons, ten casks holding twenty gallons, and three of thirty-three gallons each; five berths for the keeper and assistants, coal-bunker, and storerooms, &c., very complete.

There are three large oil-tanks, constructed of heavy block-tin, well painted and in good order.

Much ingenuity is displayed in fitting the purchase for hoisting the boat up to the davits.

The keeper of this light deserves great praise for the manner in which he keeps it; especially when it is remembered, that at the time of his taking charge of it he never saw a mechanical lamp.

The board having made a careful personal inspection of this work, which is not only novel, but bears the strongest evidence in itself of the great difficulties which attended its erection, proceeded towards the capes for the purpose of comparing the relative brilliancy and range of the different lights in sight.

The following are the results:

Brandywine shoal, third order larger model lens light, 45 feet above the level of the sea; bearing per compass NW. by N.; distant 15 miles.

Cape May, revolving reflector light, fitted with 15 sixteen-inch reflectors and lamps; elevated about 75 feet above the level of the sea; bearing N. $\frac{3}{4}$ E.; distant $8\frac{3}{4}$ miles.

Cape Henlopen, fixed reflector light, fitted with 18 twenty-one inch reflectors and lamps; tower, 72 feet, (estimated;) height of base 20 to 25 feet; 92 to 97 feet above the level of the sea; bearing W. by S. $\frac{1}{2}$ S.; distant $6\frac{1}{4}$ miles.

These distances are found by applying the bearings on the coast survey chart of Delaware bay.

These three lights having been watched by the members of the board in running down the bay until they reached the point from which the relative brilliancy of the three lights could be determined by the aid of colored and ship's glasses, they came to the conclusion, without difficulty, that the third order lens light on the Brandywine shoal, with an elevation of only forty-five feet, was more brilliant at the distance of fifteen miles (nearly its greatest range) than either the fixed light of the first class of reflector lights on our coast at the distance of six and one-fourth miles, or the revolving reflector light at Cape May, intended to be a first class seacoast light, at the distance of eight and three-fourth miles.

The comparisons were continued from this point to the Delaware break-water, and after anchoring under it; which confirmed previous conclusions.

That is to say: the Brandywine light, a third order larger model lens or Fresnel apparatus, is in brilliancy and useful effect, five and three-fourth times better than the Cape Henlopen light, fitted with eighteen twenty-one inch reflectors and Argand lamps, and three times better than the Cape May revolving light, fitted with fifteen reflectors and Argand lamps. The economical effect being in the proportion of 1 to 3.93 with Henlopen, and 1 to 3.22 with Cape May; or, Cape Henlopen expends 3.93 (near four) times more oil than Brandywine light, and Cape May expends 3.22 times more than the Brandywine light, per annum.

In addition to the saving of oil, it is believed, the saving of wicks and chimneys will be found, in practice, in the proportion of one to eighteen at Cape Henlopen, and one to fifteen at Cape May, and cleaning-cloths, buff-skins, powders, &c., &c., in the same proportion.

It cannot be urged, in this instance, that more keepers are required for the Brandywine light, with the lens apparatus, than if it were fitted with reflectors, inasmuch as a boat's crew would be necessary in either case, under the present arrangement in regard to subsistence of keepers; and to make the Capes Henlopen and May lights equal in usefulness to what they might be, even with the present apparatus, there should be two keepers to each of them, to be on watch and watch in the light-rooms during the entire night, which would remove one of the objections which has been urged against the employment of the lens on our coast.

It may be remarked, that the only three stations at which lens lights have been placed, Congress passed special laws providing them; while England, Scotland, Ireland, and the continental maritime States of Europe generally, have, during the last fifteen years, adopted the French system of illumination as rapidly as renovations could be, with propriety, made, and new necessary lights could be established.

2.—CATOPTRIC, OR REFLECTOR LIGHTS OF THE UNITED STATES, VISITED BY THE LIGHT-HOUSE BOARD.

Sandy Hook main and beacon-lights, New Jersey.

The first reflector lights visited by the light-house board were those at Sandy Hook, and in the vicinity, embracing those in New York and Princess bays.

The Sandy Hook main light, and the two beacons adjacent, serve as the principal guide to pilots and navigators in passing over the bar, and through the channels leading from sea to New York bay.

The tower of Sandy Hook main light was constructed in 1762, under royal charter, of rubble stone, and is now in a good state of preservation. Neither leaks nor cracks were observed in it. The mortar appeared to be good, and it was stated that the annual repairs upon this tower amount to a smaller sum than in the towers of any of the minor lights in the New York district.

The dwelling attached to this tower had just undergone a thorough repair, and was painted in every visible interior part, where paint could be put on—ceilings, floors, walls, and the steps of the tower, from the oil-room on the ground floor to the lantern. The painting had the appearance of having been done in great haste, and was undoubtedly put on in unnecessary places. The dwelling was not clean, notwithstanding the recent painting and repairs.

The inside walls of the tower had been recently—but two years had elapsed since the outside had been—whitewashed.

The illuminating apparatus is composed of 18 21-inch reflectors and Argand lamps, which were fitted new, according to the best information on the subject, in 1842.

The reflectors were, in many cases, out of adjustment; they were not bright, and were scratched in cleaning.

The fountains and burners of the lamps were of an old pattern, and not clean. The holders for the glass chimneys were loose and badly fitted.

The keeper is not instructed in the manner of adjusting the apparatus, and had entered upon his duties without previous instruction.

The lantern is constructed of iron, glazed with plate-glass, 24×24 inches; the astragals large, and placed vertically instead of diagonally, as they should be; the interior of the dome, although reported to have been painted white only four weeks previous to the visit of the board, was dirty, and black from the accumulation of soot, attributable to bad combustion, arising from imperfect ventilation. *The ventilators are permanently closed, and never used*; the trap-door, used for ingress and egress, is the only means employed for ventilating the lantern while the lamps are burning.

There is but one keeper allowed to this station, composed of the main and two beacon-lights, at the distance of about one mile the one from the other, containing 32 lamps and reflectors.

To perform the duty of lighting and extinguishing the 32 lamps at this station properly, it would require the keeper to walk about three miles, morning and evening, to the entire neglect of the lamps first lighted; rendering it utterly impossible to attend properly upon them during the entire night.

The present keeper employs a person (a small increase of salary having been allowed him to enable him to do so) to assist him in the performance of his duties; but the small sum allowed does not enable him to obtain the services of such a person as so responsible and important a trust demands.

The fact that there is only *one keeper at Sandy Hook*, while there are *five at Navesink*, cannot fail to be remarked upon.

The lights are not lighted at sun-setting, and kept burning until sun-rising, in compliance with instructions. The keeper uses his own discretion in this matter, generally lighting about dusk, and extinguishing at daylight.

From the best information the keeper could afford, the annual consumption of oil amounts to about 661 gallons at the main light, containing 18 lamps and reflectors. The keeper stated that the oil last year was bad; the winter-oil was cut, in cold weather, with a knife.

Supplies are furnished once during the year. The person charged with the distribution of supplies, leaves the articles in such quantities, and of such qualities, as he pleases. Bad articles are consumed, as a matter of necessity.

The Sandy Hook lights are not trimmed during the night; in the keeper's opinion, they do not require it. (It is usual to trim every three or four hours in well kept lights.)

The apparatus is repaired by the person charged with the delivery of supplies, once during the year, and he alone decides what is necessary to be done, without reference to the wishes or opinions of the keeper.

No journals of expenditures, or weather, are kept.

He has no orders to report upon the lights which ought to be seen from this light. There are no means at the keeper's command for rendering assistance to the shipwrecked.

Quarterly returns are made to the collector at New York, of the oil, &c., consumed, which amount is arrived at by deducting the quantity on hand, as near as can be ascertained, from the annual quantity received, *and not by keeping a daily account of the expenditures.*

There is no timepiece, barometer, or thermometer, allowed to this station.

The light-vessel, which is anchored six or seven miles from the light-house, is seldom seen at night from the lantern of the main light. It is sometimes seen by the aid of a ship's glass.

Neither oil-cellars, nor storerooms, are provided for this light-station. The oil is kept on the ground or lower floors of the light-towers, subjected to the great variations of temperature of places near the ground.

The glass chimneys, wicks, polishing powder, cleaning-skins, trimming scissors, cleaning-rags, &c., which ought to be kept free from dust, sand, &c., have no appropriate places set apart for them. These articles, with the spare lamps and burners, were thrown together promiscuously, on one side of the floor of the tower, which had been boarded off, and which was very dirty.

The two beacons are wooden structures, on stone foundations. Exteriors recently painted; interiors unfinished, and in bad order. The glass of the lanterns is of a very small size. Each beacon has seven lamps and fourteen-inch reflectors.

The ventilators in the beacons were found to be *permanently closed*, as in the main light.

The whole establishment was deficient in neatness.

The Sandy Hook main light has had the reputation, for a long time, of being one of the best reflector lights on the coast of the United States. The comparison made between it and the lens lights at Navesink, already given, shows most conclusively how far inferior it is to them in point of brilliancy, range, and economy; although it doubtless subserves all the useful purposes of a local navigation, as a mere harbor or bay light, (while those on Navesink serve as the sea-lights to point out the entrance to New York bay.) This light cannot properly be placed in a higher class, according to the European classification, than a third order larger model lens, which would consume about one-fourth as much oil, annually, as the present light.

The apparatus at present in the Sandy Hook light is equal to that of any reflector light on the coast, with possibly the exception of the Boston light, fitted with English reflectors, and there are only three or four which can properly rank with it. It is, therefore, beyond a doubt true, that our best reflector lights are not superior to the third order, larger model lens lights.

The distance at which the third order larger model lens light on the Brandywine screw-pile tower, with an elevation of only 45 feet, and the eye of the observer not more than ten feet from the water-level already stated, proves incontestably that none of our reflector seacoast lights, with the ordinary elevations of the light-house towers, are superior to it.

The following is a list of the lights examined by the members of the light-house board, at each of which, questions were propounded, calculated to elicit all the facts deemed necessary to a fair and correct understanding of the whole mode of management of the light-house establishment of this country.

The answers to the questions were written down, and such notes made upon the spot, as observation warranted. (See notes in Appendix, No. 2 to 43.)

- Navesink, N. J.—two lens-lights, 1st and 2d order.
- Sandy Hook—one main and two beacon-lights; reflector.
- Princess Bay light do.
- Fort Tompkins light do.
- Robbin's Reef light do.
- Sandy Hook light-boat—solid wick; compass lamp.
- Lazaretto light—Baltimore harbor-light.
- Bodkin Point light—bay-light; reflectors.
- North Point—two lights; bay-lights; reflectors.
- Beaver-tail light—coast-light do.
- Newport light—harbor-light do.
- Boston light—bay-light do.
- Minot's Ledge light-vessel—compass lamp; solid wicks.
- Isle of Shoals light—coast-light; reflectors.
- Portsmouth harbor light do.
- Portland light—harbor-light do.
- Cape Elizabeth—two lights; coast-lights; reflectors.
- Ned's Point light—bay-light; reflectors.
- Clark's Point light—bay-light do.
- Cape Henry light—coast-light do.
- Old Point light—harbor-light do.
- Willoughby's Point light-boat—solid wick; compass lamp.
- Coney Island do, do, do, do.

Back river light—bay-light ; reflectors.

New Point Comfort light—bay-light ; reflectors.

Sankaty Head light—2d order lens ; coast-light.

Brandywine shoal light—3d order lens ; bay-light.

Cape Henlopen light—coast light ; reflectors.

Cape Henlopen beacon—beacon or range-light ; reflectors.

Breakwater light—harbor-light ; do.

Cape May light—coast-light ; do.

Bombay Hook light—bay-light ; do.

Reedy Island light—bay-light ; gas, and do.

Christiana creek light—bay-light.

Bald Head light—(Cape Fear ;) coast-light.

Oak Island—two lights ; range-lights.

Prince's creek—two lights ; range-lights.

Federal Point light—coast-light.

Cape Fear river light-boat—solid wick and compass-lamp.

In addition to this, the board had opportunities of seeing, at night, all the lights in Chesapeake bay, Long Island sound, New York and Delaware bays, with the means of comparing one with another, having reference to their relative elevations, ranges, and brilliancy.

Of each of the lights visited by the board, reference to the copious notes taken at the time will show that the Sandy Hook lights are a fair sample of the whole of them. The same defects were observable everywhere ; some were in a better, while others were in a worse condition ; some exhibited evidences of care on the part of the keepers, and a desire to perform to the best of their ability the duties required of them ; others, on the contrary, exhibited a culpable indifference.

In the main the light-keepers manifested a most praiseworthy zeal in seeking for information, which can only be afforded to them through printed instructions, drawn up with care, embracing in the minutest detail all the duties of a keeper, by a corps of competent inspectors, whose visits must be frequent to insure good results.

The illuminating reflector apparatus is different in nearly every light-house which was visited by the board, and in numerous instances they differed materially on the same frame. The majority of these were spherical, and not parabolic, in shape.

The lamps are, with few exceptions, roughly and badly made ; they leak badly, in many instances, without the keepers having the means to remedy it, as the repairs are only made once a year.

The burners and chimney-holders are of the rudest description. In some instances the upper portion of the burner is made of iron, and so constructed that it can be taken off ; when in use it rests against other metal below, which produces galvanic action, and rapid deterioration ensues. The intensity of the flame is greatly diminished by the burners being of thick, heavy metal, instead of tin ; and it is believed that they require repairs quite as often, if not oftener, than those properly made of tin. There is no doubt that those burners of tin, tipped with silver, the better to withstand the great amount of heat evolved, and in general use in the few remaining reflector-lights now in Scotland, are much more economical in the end than the heavy and improperly constructed ones in the lights of this country.

The reflectors are imperfect in shape, in material, and in general a want

of proper adjustment to project the rays of emitted light to the best advantage, to the horizon.

There does not seem to have been a proper regard paid to the size and shape of reflectors, with reference to the required divergency. Many of the light-houses visited had been very recently re-fitted with small spherical reflectors; in some of which, the silver had been so badly put on the copper, that it had raised in blisters and peeled off. The reflectors were very thin in many instances.

The lamps and reflectors are, generally, badly placed on the circular iron frames—placed in the centre of the lanterns—and they are, without exception, too far apart to produce a concentrated and brilliant beam of light. Their attachments are very often of the rudest kind, and very liable to be put out of adjustment, for the want of knowledge on the part of the keepers. For the purpose of either increasing or diminishing the flow of oil from the fountains, “*tilting*” is resorted to; thereby throwing the flames out of the foci of the reflectors. One of the most delicate and important duties of the scientific lamp designer, is to ascertain the proper point for cutting off the oil, to insure a perfect flow, with proper ventilation, at all times, which is never lost sight of by the engineers of the European lights.

The glass chimneys are irregular in shape, size, and thickness, rendering combustion imperfect in most of the lamps, and a great liability to breakage from the unequal heating of the irregular thickness of the glass. A very prominent defect in all the glass chimneys is the length. All of them should be from one-third to one-half longer, and made after a model which experience has demonstrated to be the best to insure the most perfect combustion, and affording the greatest possible amount of light from an Argand burner. The representations of the keepers, and the large number of chimneys broken, attest the correctness of these conclusions. A comparison of the chimneys sent from Paris by M. Reynaud, and of those generally in domestic use, with those in use in our light-houses, will confirm this statement.

The keepers, not having been instructed to do so, seldom clean the interior of the burner, which renders the Argand lamp and burner *but little better than the exploded solid wick lamp*, which is fed with the single current of external air. Many keepers, from (as they say) notions of economy, use broken chimneys, which greatly impairs the intensity of the lights.

The interiors of the lanterns are generally dirty, and many are painted black; the astragals are large and vertical, and the glazing badly executed with putty; a large portion of the light which ought to be transmitted to the horizon is consequently absorbed or intercepted.

In some lights a very small amount of oil is consumed per lamp, producing, necessarily, a bad light, which is false economy when the purpose of the light is taken into consideration.

The supplies in general are bad in quality, and, in many instances, insufficient in quantity.

The material furnished for cleaning the reflectors is unfit for that purpose. It is used for polishing copper and brass by those who know its properties; but it is never used for silver. Whiting and rouge of the best quality are used in light-houses in other countries, for that purpose. The deleterious effects of the “*tripoli*” was seen on reflectors which had only been in use a few weeks. It would be impossible to keep reflectors in proper order with the cleaning-materials furnished to the keepers. This was so apparent to many of the keepers—especially to those who had had some experience

in light keeping—that they preferred to purchase whiting from their own small means, to using a powder which would, in a short time, render the reflectors almost useless as a means of increasing the intensity of the light.

Few keepers give their entire attention to the lights under their charge; many follow other vocations, which require them to be absent for days at a time from the lights, leaving them to be attended to by some incompetent member of the family, or perhaps, as there are numerous instances, by servants.

The present system of management, superintendence, and inspection, has been productive of evils which are becoming greater, daily, and which can only be arrested by a radical change. The most important article of supply, oil, is delivered with the other articles, and in the same manner. The oil tested at various light-houses by the oliometer, was, in every instance, below the standard. In one or two instances it was only two to three degrees below it; but in some as great as seven to ten degrees. The keepers, with few exceptions, had had bad oil, and they stated in all such cases that they were compelled to burn it.

The wicks are not of a uniform texture or closeness. Some are of a fair quality; but others were not such as the service demands, to produce good lights.

There were but two pair of trimming scissors found in all the lights visited by the board; scissors of the most common description were found at all the other lights. It is needless to add, that a lamp cannot be properly trimmed without trimming scissors.

FLOATING-LIGHTS OF THE UNITED STATES.

The floating-lights of the United States, visited by the board, were not such as the interests of commerce demand.

The light-vessel off Sandy Hook, of 230 tons, is well provided with boats, moorings, &c., &c., and everything was found to be in good order. There are two lanterns, with fourteen round and two flat wicks, through the top of a covered bowl. *There were no Argand burners nor reflectors.*

The consumption of oil was reported to be three hundred and sixty-five gallons per annum. The light is of very little use with the present illuminating apparatus, as it cannot be seen further than three to seven miles, and then very dimly. The vessel was reported to be very old, and unsuited to the exposed position off Sandy Hook. The vessel, from peculiarity of model, was represented to roll very heavily, and to be very uncomfortable in bad weather. The master of the light-vessel did not consider it safe to be in so exposed a position in that vessel, in bad weather, (vide appendix D.)

The other floating-lights visited were found to be in bad order, badly attended, and all with the inefficient illuminating apparatus already described. These vessels were in two instances found nearly deserted; in one, both the master and mate were absent, and in the other there was no one aboard but a black boy, supposed to be about twelve or thirteen years old, and the vessel in very bad condition. Nothing could be much worse than the floating-lights of the United States. The want of care and attention in wetting the decks and keeping them clean, scrubbing the vessels outside, and keeping them properly painted and well ventilated, will account for the rapid decay of them, especially in warm climates.

Many of them are not moored, but anchored by a single chain and an-

chor, with a long scope of cable; the vessel consequently describes a large circle around the anchor, destroying, in some degree, her usefulness as a range, and is in danger of fouling the anchor in swinging.

The queries addressed to nautical men were answered by civilians and naval officers commanding United States mail-steamers, civilians commanding packets and other sailing-ships, and passenger sea-steamers, or such as have been in such important positions, and by naval officers on coast-survey service. (See replies in appendix B, No. 1, et seq.) The chief results of these inquiries may be thus stated:

1. That the Navesink and Sankaty Head lens lights *are far superior* to all other lights on the coasts of the United States.

2. That the lights of Great Britain, France, and of maritime Europe, and their dependencies in general, *are superior to those of the United States.*

3. That the English lights (reflector and lens apparatus) on the Bahama banks, and the lens lights at Havana and Cape San Antonio (Cuba,) *are greatly superior to those on the coast of the United States.*

4. That the floating-lights of the United States *are far inferior* to those of England and Ireland in brilliancy, range, useful effect, and certainty of being found at all times in their proper positions.

5. That the lights and other aids to navigation in the United States compare unfavorably with those of Europe and the West Indies.

6. That the buoys, beacons, and sea-marks of the United States *do not fulfil* all the wants of commerce and navigation.

7. That the buoys are in general *too small*, and *not properly painted and marked*, to be distinguished at sufficiently great distances.

8. That lights are not sufficiently well distinguished, and the towers are too much alike to be readily known by day.

9. That sufficient care and attention is not paid to mooring and placing light-vessels and buoys; that changes of location and of distinctions of light, removal of vessels from their positions, extinguishment or lighting of lights, changes in location, color, and shape of buoys and sea-marks, are made without giving sufficient notice through the medium of the most widely circulated commercial newspapers, and by posting notices (printed in large type) at the custom-houses of this and other countries.

10. That proper facilities are not afforded the seafaring community for making known its wants, and for pointing out cases of neglect of light-keepers, and others connected with the establishment; as in France, for example, where, at the different custom-houses, a book is kept, and the masters of vessels, and others interested in commerce and navigation, are invited and expected to register all complaints or suggestions, for the benefit of the light-house engineers.

11. That the lights of the United States *are not lighted at sunset, and extinguished at sunrise*, with the punctuality and regularity which this important service demands; and that the lights, from neglect, become dim or less bright, during the later hours of the night and early hours of the morning, than they are when first lighted.

12. That many very important points on the coast of the United States require additional aids to navigation, to render it safer, more certain, and lessen the present large annual loss of human life and property by shipwreck.

Among the most prominent of the proposed aids may be named :

1. A light-vessel of the first class, to be fitted with the best reflector apparatus, for the South shoals off Nantucket.

2. A light of 150 feet elevation above the sea-level, fitted with a first order lens apparatus of a suitable distinction, with reference to the one at Montauk Point and at Fire Island inlet, be placed half-way (in the vicinity of West bay, Long Island) between Montauk and Fire Island lights.

3. A first-class light-vessel, fitted similarly to the one proposed for Nantucket shoals, to be moored on the outer or seaward end of Fryingpan shoals, (Cape Fear,) and to be kept in that position until a sufficiently elevated and powerful light is placed on Cape Fear ; to be seen, under ordinarily favorable circumstances, outside of these dangerous shoals, lying in the track of sailing vessels bound from the Gulf of Mexico to our northern ports, and of those bound to our southern ports north of Cape Florida, from Europe, the British North American possessions, and from our own ports ; and of all steamers to and from the north, to the Gulf of Mexico, island of Cuba, Chagres, &c., &c.

4. A first order lens light, with an elevation of 150 feet, half-way between Cape Henry and Body's Island light.

5. A first order lens light, with an elevation of 150 feet, near Jupiter inlet, Florida.

6. A first order lens light, with an elevation of 150 feet, near Hillsborough inlet, Florida.

7. A first order lens light, with an elevation of 150 feet, half-way between the two towers now in the course of erection at Carysfort reef and Sand Key, Florida.

Second, only, in importance to the foregoing proposed new structures, is the necessity for substituting first order lens apparatus in place of the present inferior reflectors, and giving to each tower an elevation of not less than 150 feet, at the following points, where first-class sea-coast lights are indispensable to the safety of commerce, viz : Gay Head, Montauk Point, Fire Island inlet, Barnegat, Cape May, Cape Henlopen, Assateague, Smith's island, (Cape Charles,) Cape Henry, Cape Hatteras, Cape Look-out, Cape Fear, Cape Romain, Charleston, Cape Canaveral, Tybee, Cape Florida, Dry Tortugas, Sand island, (near Mobile Point,) Pensacola, and the two principal passes at the mouths of the Mississippi.

13. That the lights along the southern coast from Navesink are greatly inferior to the lights further east, and are, in their present condition, of very little use to the mariner.

14. That the proposed additional lights for the Florida coast should have such elevations, and illuminating apparatus, as will insure a range that will bring two lights in sight when midway between them. (For details, see general programme attached as part of this report.)

15. The questions addressed to the general superintendent of lights, &c., and local superintendents, master of the vessel employed to distribute supplies, the collector of the port of Boston, by whom the oil and other annual supplies, apparatus, &c., &c., are purchased, are given, with the replies (omitting only the portions containing reflections on individuals, which the board do not deem it proper to admit into this report,) in appendix C, No. 1, et seq.

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The facts obtained from these papers will be stated under the different heads of the report.

The following extracts and abstracts from the letters of the general superintendent of lights, will give a general idea of the present system.

The law of August 7, 1789, authorized the Secretary of the Treasury "to rebuild when necessary, and keep in good repair, the light-houses, beacons, buoys, and public piers in the United States, and to furnish the same with all necessary supplies;" the management of the establishment was then placed under the commissioner of the revenue, and in 1821 under the present general superintendent of lights, &c., &c.

The Secretary of the Treasury is also authorized to "agree for the salaries, wages or hire, of the person or persons appointed by the President for the superintendence of the same."

The collectors most convenient to the lights, without regard to their collection districts, were appointed, first by the President, and afterwards by the Secretary of the Treasury, as superintendents of lights, &c., to act under the general superintendents at the seat of government. These local superintendents, under the law of May 23, 1828, receive a commission of $2\frac{1}{2}$ per cent. on their disbursements, limited, however, to \$400 per annum.

Sites for authorized light-houses were selected by these local superintendents, assisted by retired pilots and ship-captains, under the direction of the general superintendent. The contracts were made by the local superintendents, who appointed mechanics as overseers of the work. The local superintendents are directed to visit all the lights in their districts *once a year*, and report their condition, and the conduct of the keepers, to the general superintendent.

The towers are of four different elevations—65, 50, 40 and 30 feet.

The illuminating apparatus is not made and fitted under the direction of a competent engineer, but by a custom-house officer, and a mechanic.

"I have had much inconvenience and difficulty to encounter from the frequent changes incidental to our form of government, in the light-house keepers, who, for a time, do not understand the management of their lamps, and consequently keep bad lights and waste much oil." "So necessary is it that the lights should be in the hands of experienced keepers, that I have, in order to effect that object as far as possible, recommended, on the death of a keeper, that his widow, if steady and respectable, should be appointed to succeed him."—(Vide letter of general superintendent of lights, June 7, 1851, appendix C.)

* * * * *

"The keepers are not instructed previously to entering upon their duties;" "the trimming and cleaning of a small Argand fountain lamp being so simple and self-evident, as to be safely left to the intelligence of the meanest capacity."—(Vide letter of the general superintendent of lights, &c., July 3, 1851, appendix C.)

"All the oil, tube-glasses, wicks, buff-skins, tripoli, lamps and reflectors, and parts of lamps and oil-butts, are procured twice a year by the collector at Boston, by advertisement, and forwarded to the light-houses on the Atlantic coast, formerly by one vessel, but now by two vessels; beginning in the spring at St. Mary's, in Georgia, and going eastward to Passamaquoddy."

"A lamp-maker is taken on board for the purpose of repairing the lamps, for which he has the necessary material with him." "In the fall of the year the supplies, procured in the same manner, are sent south from St. Mary's."

Oil, &c., for the lakes, is sent to Buffalo, and other points in their vicinity. Two kinds of oil are used, "winter and summer" strained sperm oil.

"The buoys established by law are very numerous, and on many points of the coast are attended and kept in their places with great difficulty, and at considerable expense."

"There are four gas-lights, which, in consequence of the keepers not giving timely notice of the necessity for new furnaces and retorts, would be extinguished three to six months in the year, if oil-lamps were not kept at them."—(Vide letter of general superintendent of lights, June 7, 1851, appendix C.)

"There is no formal classification of lights."

"As there is no formal classification of the lights, the number classed as first class, or order, cannot be given;" "but in what may be considered first order lights, except the lens lights" (three—two of the second order and one of the third order) "the diameter of the burners is three-quarters of an inch; the diameter of the reflector is 21 inches." (Thirty in all, according to the latest list, and many of them with only nine to twelve lamps, and averaging only thirteen lamps, among which will be found Fort Tompkins bay light, nine lamps; Ocracoke harbor light, ten lamps; and Chandelier island light, nine lamps.) * * "The only modes of distinction for first-class lights, are fixed white and revolving white. These are the most efficient, and cheapest."

"There are no reflectors in use of an inferior quality, to my knowledge."

The reflector lamps are Argand, "with three-quarters of an inch diameter burners, made of iron, and not tipped with silver."

"They (the reflectors) will last from ten to twenty-five years, according to their proper use or abuse."

"The illuminating apparatus used in our light-vessels is the compass-lamp."

"No Argand burners and lamps are used." "It is simply a reservoir to hold the oil, with a number of wicks placed around the circumference."

"The expense of repairs for the lamps alone has not been kept separate."

"There are no special oil-cellars." "The lanterns are constructed of wrought iron; not of bronze."

"The system of ventilation in general use, is by a top ventilator, traversing, of various forms, or Collins's patent, and by side ventilators (generally closed,) on the base of the lantern or in the lantern doors; but these means are very inferior to what is furnished by the scuttle-door being left open."

"Professor Farraday's ventilating tables are not used, as the open scuttle supplies a power of draught and a quantity of air sufficient for perfect combustion without them." *

The important branch of ventilation in light-house engineering, has received the attention and consideration, and has been experimented practically upon, by the ablest and most scientific persons in Europe; and the results of their labors have greatly contributed to the improvement of the lights, especially in those of France and Great Britain. The ventilator introduced by European light-house engineers, is one of the essential parts of all the apparatus constructed, either for home or foreign use.

"There is not what may be called any general system of construction."

* A due consideration of the facts relating to the motion of air, will show that proper ventilation cannot be had by the means here referred to.

"The kind of tower, if for difficult locations, is sometimes made at this office; sometimes by the experienced engineers employed by me for that purpose, and in all cases examined and approved by me." (Vide letter of general superintendent of lights, July, 1851; appendix C.)

There is no systematic plan or arrangement, by which repairs are made.

"Light-vessels last from five to ten years, according to latitude and timber. The average annual repairs are very great." (Vide letter of general superintendent of lights, appendix.)

"The buoys are placed by contract with pilots; they are taken up and replaced in the same manner." (Vide letter of the general superintendent of lights, July, 1851; appendix C.)

For the mode of purchasing and distributing supplies as exhibited by those intrusted with these important duties, the board refers to the letters of the collector of Boston, and of Mr. Howland, the person charged with the delivery of supplies.—(Appendix C, Nos. 18 and 19.)

The general system seems to be, that the coast of the United States is divided into districts, and placed under the superintendence of collectors of the customs, without regard to whose districts the lights may be in.

The local superintendents of lights receive a per-centage on all disbursements for repairs, new structures, &c., &c., &c. They are directed to visit each light once a year, and report the condition of them to the general superintendent. This latter duty is also required of the master of the supplying vessel, who delivers oil and other supplies once a year, going south in the winter, and north in the summer. Supplies are purchased in Boston, by the collector of that port. The lamps and reflectors are also made and purchased there. Many of the light-houses have been built, indeed nearly all of them, by Boston contractors.

Mechanics are employed to superintend the construction of new buildings, upon whose certificates the amounts of the contracts are paid. The local superintendents recommend, and afterwards order such repairs as the general superintendent may authorize. The certificates of the keepers, in cases of repairs, are generally required and considered satisfactory.

The number of keepers and assistants is only regulated by the appropriations. As a general rule, but one keeper is appointed to a light-house, but in some cases an assistant is allowed; and in others, an increase of salary is given as a reward for extra services.

The general superintendent under the law of 1789, under which the present light-house establishment has grown up, has authority to introduce any apparatus, make renovations, remove or rebuild towers, replace buoys, &c., &c., at his pleasure. The law which permits the purchase of new lanterns, plate-glass, new lamps and reflectors, movable machinery, &c., will equally permit the purchase of lenses for towers, and parabolic reflectors and Argand lamps for light-vessels.

The law appropriating annually large sums for the maintenance, repair, and renovation of light-houses and light-vessels, does not prescribe what towers, vessels, or apparatus are to be repaired, nor does it specify what is to be placed in these towers and vessels in place of the old apparatus.

The board collected, also, the reports on the condition of the light-house system of the United States in past years, as assisting in their deductions in reference to the present condition, by showing its antecedents. Extracts from them are given in the appendix, and will be referred to in the course of this report.

The board would here refer specially to the reports of the Hon. John Davis, chairman of the Committee on Commerce in the Senate, recommending the introduction of the lens or Fresnel system of illumination, as being superior to the reflector system followed in this country, and also recommending a change in the mode of superintending and inspecting the lights; also, to the notes of Commodore Perry, United States navy. The extracts from the reports of officers of the navy, detailed in conformity to law, to inspect and report upon lights, &c., on the coast of the United States, will be found to contain information and conclusions which the board has no hesitation in confirming at the present time, and are therefore considered well worthy of the attention and consideration of those interested in effecting improvements in this important branch of the public service.—(Appendix O.)

To the report of the Hon. R. J. Walker, Secretary of the Treasury, and the extracts accompanying it, from Senate document No. 488, first session twenty-ninth Congress, especially the valuable papers from M. Léonor Fresnel, the eminent engineer and secretary to the "Commission des Phares," of France, the board invites particular attention, as containing undoubted facts and deductions relative to the lens system for illuminating light-houses, which the longest practical experience has confirmed in England, Scotland, Ireland, and in general throughout the whole of maritime Europe, and to the correctness of which, experimentalists have everywhere given most willing testimony. The public documents containing facts and opinions furnished by the most eminent seamen in our commercial marine, (masters of our New York and other packet ships, &c.,) by officers of the navy, engineers of high standing and undoubted ability, and by other disinterested individuals who have given testimony on this most important branch of the public service, are referred to with great confidence by the board.—(Vide appendix O.)

The light-house system of the United States has grown up from small beginnings—only eight lights in 1789, and fifty-five lights in 1820—to its present enlarged condition of three hundred and thirty-one lights in 1851, and without those helps from organization of which some other countries have had the advantage. Great credit is due to the zeal and faithfulness of the present general superintendent, and to the spirit of economy which he has shown. The systems of lighting, however, which twenty-five years ago were in general use, have gradually given way to *more improved ones—more efficient and more economical.*

The general condition of our lights is not, in the opinion of the board, such as our commerce now requires, and not such as the improvements of the day can supply.

In considering the condition of the different parts of the system in their order, these facts will strongly appear, viz: that waste of light, by imperfect apparatus, is waste of oil, and must be paid for in money. The navigator would be more benefited by a few good and reliable lights than by many imperfect ones; indeed he would prefer no light at all to a bad one.

CLASSIFICATION OF LIGHTS.

A proper classification of lights has many and obvious advantages; in fact, it forms the basis of the arrangement of lights in a system.

In England the shore lights are classed as SEA-COAST, SECONDARY, RIVER,

and HARBOR LIGHTS. In France they are divided into six orders, according to the size of the illuminating apparatus. The name of the order of the light in the French system suggests its purpose, the range, the relative brilliancy, the size and character of the parts of the illuminating apparatus, and the particulars of detail.

That our own lights have not been classed (vide letter of general superintendent of June, 1851, appendix C,) will explain the many anomalies in the number of lamps, the forms of the reflectors, and the like.

It is an admitted principle, that the degree of divergency given to a light by a reflector for light-house purposes, should depend upon its intended objects, including range, &c., &c.; and yet no such principle has been applied in our light-houses, and a waste of light has been the consequence. Classification is of little avail without other and more important qualities; but it is nevertheless an essential of a system.

The following is an assumed classification of the lights of the United States, according to their present value and useful effect, as compared to the lens :

1. One station with a first order fixed and a second order revolving lens light. This combination renders the light only equal to a second order lens light.

2. One station with a second order flashing light (lens.) This light is not fully equal to a second order lens, constructed on the most approved plan, in consequence of the loss of light by metal placed in the focal plane.

3. One station with a third order larger model lens light, constructed on the most approved plan.

4. One station with a revolving light, twenty-one 21-inch reflectors, the nearest approximation to a first order catoptric light on the coast; inferior to a second order lens light.

5. Three stations with eighteen 21-inch reflectors (fixed light;) not better than second order catoptric, or third order dioptric light.

6. One station with thirty 18-inch reflectors, (two lights in one tower) not better than second order catoptric, or third order lens light, (larger model.)

7. Four stations with eighteen 15-inch reflectors; about equal to third order lens light, (larger model.)

8. Two stations with seventeen 21-inch reflectors; about equal to third order lens light, (larger model.)

9. Nine stations, fifteen 21-inch reflectors; not equal to a third order lens light.

10. Eight stations, fourteen 21-inch reflectors; inferior to third order lens light.

11. Fourteen	"	fifteen	15	"	"	"	"
12. Three	"	sixteen	15	"	"	"	"
13. Eight	"	fourteen	16	"	"	"	"
14. Eleven	"	thirteen	14	"	"	"	"
15. Three	"	twelve	21	"	"	"	"
16. One	"	twelve	16	"	"	"	"
17. Four	"	twelve	15	"	"	"	"
18. Three	"	eleven	21	"	"	"	"
19. Twelve	"	eleven	16	"	"	"	"
20. Nine	"	ten	21	"	"	"	"
21. Eighteen	"	ten	15	"	"	"	"
22. Forty	"	ten	14	"	"	"	"

23. Thirty-nine stations, eight 14 and 15-inch reflectors ; inferior to fourth order lens, (larger model.)

24.	Twenty-eight sta'ns, eight	14	"	"	"
25.	Two " eight	16	"	"	"
26.	Two " nine	21	"	"	"
27.	Eighteen " seven	14	"	"	"
28.	Fourteen " six	14	"	"	"
29.	Two " two	16	"	"	"
30.	Eight " four	14 & 16	"	"	"
31.	Fourteen " eleven	14	"	"	"
32.	Four " one	14	"	"	"
33.	One " eight	9	"	"	"
34.	Eight " five	14	"	"	"
35.	Four " three	14	"	"	"
36.	Nine " without reflectors.				

RECAPITULATION.

1	tower with 30 lamps ; (two lights in one tower.)
1	" " 29 "
1	" " 21 "
7	" " 18 "
2	" " 17 "
3	" " 16 "
23	" " 15 "
16	" " 14 "
11	" " 13 "
8	" " 12 "
29	" " 11 "
67	" " 10 "
2	" " 9 "
70	" " 8 "
18	" " 7 "
14	" " 6 "
13	" " 5 "
8	" " 4 "
5	" " 3 "
2	" " 2 "
7	" " 1 "
5	" " small gas lights.
4	" " lens lights.
37	towers with 21-inch reflectors.
1	" " 18 " "
41	" " 16 " "
51	" " 15 " "
168	" " 14 " "
1	" " 9 " "
9	" without reflectors.

Lens lights.

One station equal to second order lens light.
 One station not equal to second order lens light.
 One station with third order (larger model) lens light.

Reflector lights.

12 lights not equal to second order lens light.
 61 lights not equal to third order lens light, (large size.)
 35 " " " " " (small size.)
 121 lights not better than fourth order lens light.
 84 lights inferior to the fifth and sixth order lens light.

It is apparent from this statement that there is not a first-class light of any description on the whole coast of the United States. The nearest approximations are at the Highlands of Navesink, composed of a first and second order light, and the revolving reflector light at Mobile Point, of 21 reflectors.

The three next in order are Sandy Hook, Cape Henlopen, and Cape Henry, each fitted with 18 twenty-one inch reflectors, and in towers of a good elevation.

The Boston harbor light, fitted with 14 twenty-one inch English reflectors, probably *now* stands next on this list, although the apparatus is much worn, and has not had the care and attention it deserved.

There are 236 fixed lights.

30 revolving lights.

2 fixed and revolving lights.

18 double lights.

2 triple lights.

Average number of lamps per light-house, in the United States, is now $9\frac{1}{2}$.

Average number in England, (general coast,) 13.

" " Scotland, (general coast,) $17\frac{1}{2}$.

" " Ireland, (general coast,) 20.

" " Ireland harbor, $7\frac{1}{2}$.

The 41 light-vessels of the United States are fitted without lamps, (in the ordinary acceptation of the term,) and *without reflectors*. The lights are consequently seen at very short distances, and do not fully subserve the objects for which they were authorized by Congress.

Argand lamps, with large parabolic reflectors, are employed in Great Britain in light-vessels.

The Admiralty list of Trinity House lights for 1849, shows that there were at that time seven floating lights fitted with revolving apparatus, belonging to that corporation.

DISTINCTIVE CHARACTERS.

The distinctive characters of the lights of the United States, are :

1st, fixed lights.

2d, revolving lights.

3d, double lights, or lights in two towers.

4th, lights in three towers.

5th, colored lights.

Distinctions have been employed at ten stations from two fixed lights, and from one fixed and one revolving light; and in three towers with two lights, one above the other. There is but one triple light on the coast of the United States. The beacons for ranges are not, of course, included in these numbers. Double and triple lights are among the most wasteful modes of distinction, and, it may be added, *the least effective*. Very little attention has been paid to distinguishing lights in the United States. At points along the eastern coast, many fixed lights are seen at the same moment, without the means of knowing any of them. The proportion of revolving to fixed lights on the entire coast, is 1 to 9.2. The proportion of all modes of distinction, including multiple and colored lights, is 1 to 5.2.

On the coast of Maine there are 34 light-stations; of which number, 3 are revolving, 1 two-towers fixed and revolving, 1 two-towers fixed lights, and the remaining 29 are all fixed lights.

In New Hampshire there are 3 light-stations: 1 fixed, 1 revolving red and white, and 1 fixed, with two lights in one tower.

In Massachusetts there are 42 light-stations; of which 5 are revolving, 11 fixed and revolving, 1 lens, flashing, 8 double fixed, 1 triple, and the remaining 26 are fixed white lights.

In Rhode Island there are 9 stations; 2 are revolving, and 7 are fixed lights.

In Connecticut there are 11 stations; 2 are revolving, and 9 fixed lights.

In New York there are 41 light-stations; 4 are revolving, and 37 fixed lights.

In New Jersey there are 10 light-stations; 1 revolving, 1 fixed and revolving, 1 red, and 7 fixed lights.

In Pennsylvania there are 4 light-stations, and all fixed lights.

In Delaware there are 8 light-stations, and all the lights are fixed. The one on the breakwater *is called* a red and white light, by the keeper; but as the light cannot be seen through the dark red shield-like shades, the white part only is seen.

In Maryland there are 14 light-stations; 1 double fixed, and 13 single fixed lights.

In Virginia there are 8 light-stations; 2 are revolving, and 6 are fixed lights.

In North Carolina there are 11 light-stations; 2 are revolving, 2 double fixed lights, and 7 fixed lights.

In South Carolina there are 5 light-stations; 1 revolving, 2 double fixed light-beacons, and 2 fixed lights.

In Georgia there are 9 light-stations; 2 revolving, 1 two fixed beacons, and 6 fixed lights.

In Florida there are 12 light-stations; 6 revolving, and 6 fixed; one of the latter with red shades.

In Alabama there are 3 light-stations; 1 revolving, and 2 fixed lights.

In Mississippi there are 4 light-stations, and all fixed lights.

In Louisiana there are 14 light-stations; 3 revolving, 1 with two lights in one tower, 1 red light, and the remaining 9 are all fixed lights.

Of the remaining 49 lights, *only two* are revolving.

The foregoing lights are exclusive of the 42 light-vessels distributed

along the coast, forming an important part of the light system, all of which are fixed lights.

From the Highlands of Navesink to the fixed light on Dry Tortugas, a distance of upwards of 1,300 miles by the coast, there are only 3 prominent revolving lights; all the rest being single fixed lights. The revolving lights at Cape Charles, at Ocracoke, Sapelo, and Amelia island, are not included in this estimate, because they are minor lights, and not seen, except by vessels bound into ports near their location. Body's island is so badly placed, and so low, that it is of very little use to navigators.

From Dry Tortugas to Cape Canaveral, a distance of nearly 400 miles, there is not a single revolving or other than fixed lights.

From Charleston to Cape Canaveral, a distance of 300 miles, all the prominent lights are fixed, with only two minor revolving lights.

From Charleston to Navesink, there is but one revolving light which can be of any use to the mariner bound to New York.

In England the lights are distinguished by fixed, revolving, flashing, colored, (red only being used,) with combinations of double fixed, fixed and revolving, &c., &c.

The English Trinity House Corporation have 7 revolving lights on board of light-vessels, out of 25; and the proportion of revolving to fixed lights is 1 to 4.2. Of 40 sea-coast lights, 19 are fixed white, 10 revolving, 4 revolving and fixed, 3 red fixed, and 1 double fixed light; that is, one-half are fixed, and the remaining half are revolving, &c.

The Scotch have 11 fixed white; 2 revolving red and white; 4 revolving, showing brightest every minute; 4 revolving, and showing white lights every two minutes; 2 double fixed lights; 2 flashing once in every five seconds; 4 intermittent lights, brightest state once in two minutes; 2 fixed and red; 1 double, revolving at the same instant; making only 11 fixed lights, out of 33, on the entire coast of Scotland.

In Ireland there are five distinctions employed: fixed white, fixed red, revolving white, revolving red and white, and intermittent lights. Of 23 sea-coast lights, 11 are fixed white, 7 revolving, 1 fixed red, and 1 fixed and revolving.

In France there are nine principal combinations of lights, possessing distinctive characteristics, viz:

1. Flashes which succeed each other every minute.
2. Do. do. do. every half minute.
3. Do. alternate red and white.
4. Fixed lights, varied by flashes every four minutes.
5. Do. do. do. every three minutes.
6. Do. do. do. every two minutes.
7. Do. white lights, varied by red flashes more or less frequently.
8. Fixed lights.
9. Double fixed lights.

To which might be added fixed and revolving, in two towers, as at Navesink. There are, however, very few double lights in France, and are only employed to give a very decided character to a locality, in contradistinction to those nearest.

By adopting the principle of Rear Admiral Rossel, as set forth in the programme reported by him for lighting the coasts of France, in 1822, finally adopted by the French administration in 1825, and which has been steadily adhered to since, of placing first order sea-coast lights within the distance

of forty-two nautical miles of each other, there can be no great difficulty in obtaining a sufficient number of very marked distinctions for sea-coast lights. The present advanced and progressive state of nautical science is also brought in to the aid of the light-house engineer, as it will now seldom happen that a navigator will be eighty-four miles out of his reckoning.

By commencing at one line of the boundary of a country, on a sea-coast where a first order light is required, with a revolving light; then, at the distance of forty-two nautical miles, a fixed light; and at the distance of forty-two nautical miles further, a flashing light; then an intermittent bright, then a fixed light; then a revolving—and so on along the entire coast—the mariner will find no difficulty in recognising any well kept light that he may see. Should it become necessary to employ time as one of the elements, then there can be no better system than that employed in France.

An occasional deviation may be found to be necessary, such as the erection of two towers for fixed, revolving, or fixed and revolving lights.

This is one of the branches of light-house service which can only be executed properly by competent persons, who have thoroughly investigated and studied the subject, both in general and for special cases.

Should the very ingenious plan of distinguishing lights by occultations, as proposed by Mr. Charles Babbage, prove, upon experiment, to be practicable, the whole system of characteristic distinctions will be entirely changed and greatly simplified. (See appendix BB.)

The floating lights of the United States are all fixed, and fitted with common torch lamps, without Argand burners and reflectors. (See letter of general superintendent, appendix C.)

The light-vessels are too small for exposed positions, and the models are not the best for the purposes for which they are designed. They are not provided with moorings such as they require, and there is not sufficient attention paid to placing them in their proper positions.

The lights, in consequence of the inferior lamps *without reflectors*, are of very little use to the navigator. The uncertainty of finding the light-vessels in their proper positions, by navigators who have been several months absent from the country, produces a general distrust, which destroys all reliance on them.

The floating lights of England and Ireland are built upon the best models; are of sufficient tonnage to be safe at the points for which they were built; are constructed in the most substantial manner—of wood generally, but in some cases of iron; are moored with heavy anchors and chains, and long scopes. Those placed to mark channels, as the N. W. light-vessel at Liverpool, are moored with long scopes of cable to a swivel, and hove in, so that in swinging they do not change their positions perceptibly. These floating lights are placed in the most exposed positions in the Irish or St. George's Channel, in the British Channel, North Sea, and in the most exposed positions of the English and Irish coasts. It very seldom happens that they break from their moorings, and are never taken away without previously placing a duplicate in the position.

The system of relief to the keepers and crews is an admirable one; one that insures a faithful performance of the duties intrusted to them, to the great advantage of navigators. (See Senate Doc. No. 488, 1st session 29th Congress; and letter of Wm. Lord, esq., R. N., &c., &c., H, No. 11.)

The English floating lights are fitted with Argand lamps and parabolic reflectors—fixed, revolving, and double lights. They are distinguished by

along the coast, forming an important part of the light system, all of which are fixed lights.

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The English floating lights are fitted with Argand lamps and parabolic reflectors—fixed, revolving, and double lights. They are distinguished by

day by cages of hoop-iron, balls, cones, flags, &c., &c. The name and number of each light-vessel are painted in large letters and figures conspicuously on the sides and stern.

These lights, from the superior apparatus employed in them, and the great care and attention of inspections and superintendence, under the most rigid instructions in detail, (which are printed in large type and hung in frames in the apartments,) are very little inferior to the same class of reflector lights, with equal elevations, on shore. Many of them can be seen from the deck of a merchant vessel twelve to fourteen miles, while those in this country can only be seen from three to seven miles.

Refractors have been made by Mr. Letourneau, of Paris, for light-vessels, which cannot fail to be productive of much benefit, and which are, no doubt, destined to render floating lights much more useful to the navigator than they have hitherto been, even in England, where the best reflecting apparatus has been employed for many years. (Vide appendix, and letter of T. Letourneau, of Paris.)

MODE OF ASCERTAINING PLACES OF LIGHT-HOUSES, ETC.

No systematic mode of determining where there should be a light-house, or boat, seems to have been followed for any period of years, and hence the lights are so numerous in some parts of the coast as to be inconvenient, (vide letter of general superintendent of lights) and on other parts are so few as not to supply, *even moderately*, the demands of navigation.

The principle adopted by the French commissioner of light-houses for placing lights on the coast of France, will be found stated in another part of this report: steadily adhered to, it has prevented the wasteful multiplication of lights, and has provided, gradually, those really necessary for facilitating navigation.

The law, and the instructions of the department, call upon the board for a programme for the coast of the United States, "to guide legislation" on this important point.

The act of Congress of March 3, 1851, directs also, "That, if such person as the Secretary of the Treasury shall designate shall report, in any of the cases herein provided for, that preliminary surveys are necessary to determine the site of a proposed light-house, light-boat, beacon or buoy, or to ascertain more fully what the public exigency demands, the Secretary of the Treasury shall, thereupon, direct the Superintendent of the survey of the coast of the United States to perform such duty on the seaboard, and the Colonel of the corps of topographical engineers to perform such duty on the northwestern lakes."

This proviso insured a report in all doubtful cases. It appears, also, to be the next subject to be considered, viz: "Special selections of sites for light-houses." These were to be selected on surveys made as just stated. In 1851, thirty sites were thus examined and reported upon by the Superintendent of the coast survey, on actual examinations and reports made by the hydrographic officers of the work. The expense is stated to have been less than one thousand dollars.—(Report of superintendent coast survey for 1851.) The board recommend a continuance of this system.

PLANS FOR LIGHT-HOUSES, LIGHT-VESSELS, LIGHTING APPARATUS AND ITS ACCESSORIES.

No systematic methods appear to have been resorted to, to secure plans for light-houses, light-boats, lighting apparatus and other accessories, in the United States. The preparation of plans for light-houses, lighting apparatus and other accessories, is the business of an engineer. Occasionally architects have been consulted, and the Treasury Department and Congress have sometimes devolved the preparation of plans, &c., upon the officers of the corps of topographical engineers. *The uncalled for variety and the inconvenience and ill-adaptation of the structures visited by the board, show how much the intervention of knowledge is required.* In discussing the details of these works, this fact will constantly appear. Professional skill is essential to efficiency and economy. Ill-contrived light-houses require numerous additions, and do not then answer their purpose. Badly constructed ones are expensive in repairs, besides injuring the apparatus and stores contained in them. Badly contrived lamps waste the oil, and answer imperfectly the purpose of lighting. Mirrors badly made, unskilfully arranged, unscientific in their forms and adjustments, cause a loss of light which is paid for in oil. Imperfect ventilation causes a bad light. Unscientific arrangements of the lantern in regard to glazing, painting, &c., cause a waste of light. The proper arrangement of these matters is the study and occupation of a profession. The neglect of the proper conditions is wasteful. Plans of light-houses of different classes, with modifications adapted to different localities, would promote economy by the frequent repetition of the same pieces, which in stone work, brick work, iron-casting, carpenter's work, glazier's work, and the like, is productive always of a decided economy.

The important subject of alarm signals has not received the attention which it deserves. In the English light-houses the gong is used instead of the bell, to give signals in case of fogs, and no attempt appears to have been made in this country to compare the value of the two kinds of alarm signals. The fog-whistle, introduced by Mr. Daboll and recommended by the board, has been found to be far more efficient than the bell.

The board had ample means of forming correct conclusions as to the relative merits of the two modes of warning the mariner in fogs, and found no difficulty in deciding in favor of the whistle, for positions where it can be put up.—(See appendix K, and plates.)

Mr. Alexander Gordon, civil engineer of London, proposed to the select committee of the House of Commons on light-houses, in 1845, that the gong employed on board of light-vessels should be superseded by the use of a shrill scream or whistle, such as the railway whistle, giving it sound by a bellows, and having the sound directed around the horizon by reflectors, similar to those of Bordier Marcet for reflecting light.—(See appendix K, No. 9, and plates.) The reflection of the sound of the air-whistle of Mr. Daboll is believed to be practicable by the means suggested by Mr. Gordon; at any rate, the importance of the subject warrants the small expenditure which would be required to test it experimentally.

The discharge of heavy guns has been recommended, and would be effective if there were sufficient force at the light-houses to load and fire them. They would always be expensive, however, every discharge of a twenty-four pounder gun costing about one dollar.

The fog-bells examined by the board were not placed so as to produc

the best effect. That at Boston harbor was enclosed in a frame building, the sides of which effectually deadened the sound in two directions.

It is time that this subject received full and careful investigation by experiments under the direction of scientific men. Besides this class of signals, those intended to guide vessels entering into *barred* harbors, when (from heavy weather or other causes) pilots cannot be had, should be carefully systematized. The board presents in the appendix (L, No. 1,) the system of Captain Fenoux, of the French navy, depending upon the positions of a movable triangle fixed to a pole or mast, or to a light-house; and that of Lieutenant John Rodgers, United States navy, by a flag, to be used in a boat or on shore.

Surf-boats and life-boats should be furnished to certain light-house stations, and the means of readily providing crews for them in time of need, be furnished.

They should be planned by, and constructed under the direction of, competent persons, who would study all the details of their use, and make it certain that when required they could be launched and effectively manned.

The trustees of the Liverpool Dock Company (England) have, under the admirable management of their very able Marine Surveyor, (Wm. Lord, esq., R. N.) of that port, a most perfect system for the relief of the shipwrecked.

There are nine life-boats stationed at different points around the bay and port of Liverpool. The boats are constructed on the most approved principles; kept on carriages in the boat-houses near the shore, and horses provided to enable them to proceed to the most advantageous spot for launching. A gun is placed at each station to summon the crew, besides distress flags placed at each light-house, light-ship and telegraph station. The arrangements are so perfect, that in many instances the life-boat has been manned, launched, and on her way to the wreck in seventeen or eighteen minutes from the time the distress signal was made.

The life-boats are manned by picked boatmen of Liverpool and picked fishermen along the coast, who reside near the boat stations, and who are familiar with the banks, swashways, tides and currents, in Liverpool bay. The whole of the boatmen are kept on constant and permanent pay, and are regularly mustered and exercised once a month, and no expense has been spared in rendering the boats, their equipments and crews, as perfect as possible.—(Vide letter of Wm. Lord, esq., appendix.)

The Liverpool arrangements are well worthy of imitation for many parts of our dangerous coast, (especially during the winter months.) The board cannot too strongly urge the necessity for the employment of more efficient means than now exist, at the points where life-boats have been authorized, by law, to be placed.

LIGHT-BOATS AND THEIR ACCESSORIES.

The first cost, large annual expense for maintenance and repairs, and the rapid decay of light-vessels, render this mode of lighting very objectionable, independently of the ineffectual manner in which they subserve the purposes of warning the mariner of danger.

That this description of lights has not received the attention in this country, due to its importance as a necessary adjunct to a proper system of sea-coast illumination, is very evident to the board.

That there are many points on our extended sea-coast requiring to be lighted, which will not admit of any other means, is also evident.

It therefore becomes necessary to select those means least objectionable, in an economical point of view, and best adapted to the desired end.

The rapid decay of timber, especially on our southern coast, would seem to suggest the propriety of employing more durable materials. It is stated by the general superintendent of lights that these vessels last from five to ten years. To obviate the necessity for renewing them at such short periods, iron vessels might, with great propriety, be substituted. The experiment has been tried in Europe with perfect success—(Vide letter of Wm. Lord, esq., R. N., Marine Surveyor of the port of Liverpool, appendix H, No. 11; and Ex. Doc. 488, 1st session 29th Congress.)

The advantages of iron over wood for the construction of light-vessels are self-evident. Durability, buoyancy, and economy of first cost, are the advantages, without any conceivable disadvantages that could arise from their introduction.

The inferiority of those vessels seen by the board, the large sums appropriated annually for their support and repair, and the small amount of usefulness arising from their employment, warrant the board in recommending a better class of vessels; to be built of iron, and filled with the best parabolic reflectors and Argand lamps, similar to the N. W. light-ship at Liverpool and those generally employed by the Trinity House board and Irish board. Proper distinguishing marks by day, as well as the distinctions of the lights at night, should not be neglected, and the board cannot do better than recommend the Liverpool and other English light-vessels, as proper models, in every respect worthy of imitation.

There are many points on our southern coast, especially in the sounds and bays, where small light-vessels are now placed, at which screw-pile foundations might be substituted with great advantage to the navigator, and in an economical point of view. Structures on screw-piles costing in the aggregate much less than the light-boats, and affording a more powerful and efficient light, would, in the opinion of the board, conduce greatly to the efficiency and economy of this branch of the lighting service of the United States.

The apparatus of the light-vessels of this country is so far inferior, that most intelligent and disinterested persons engaged in commerce and navigation pronounce them useless—(Vide appendix B, No. 1 to No. 39.)

The example of the Trinity House corporation, Liverpool lights establishments, &c., &c., in fitting up their light-ships with 21-inch parabolic reflectors and Argand lamps and burners, has not been followed in this country. While the light-vessels of this country are comparatively useless, those of Great Britain are in many instances equal, and in all nearly so, to those placed in towers on the shore. The introduction of movable machinery, with the view to distinguishing these lights, is not of very recent date in Europe, though not known here.

The removal of light-vessels from dangerous and important points on the coast, without due notice, (a source of almost universal complaint by masters of vessels,) is an evil that cannot be remedied too soon. It has not been many days since the finest steam-frigate in the navy struck on a dangerous shoal, properly laid down on the coast-survey chart, in consequence of the absence of the light-vessel from her position. Light-vessels seldom break away from their moorings in England, and are never taken away from their

positions without previously placing a substitute. This branch of the lighting service of this country is probably the most defective. Properly modelled, built and moored, light-vessels, fitted with the best apparatus, and placed under the charge of competent masters, with ample crews, governed by the most rigid rules and regulations, and subjected to frequent visitation and inspection, can alone subserve the great interests of navigation, in this branch of the lighting service. (Appendix D, No. 1, 2, &c., &c.)

MATERIALS AND MODE OF CONSTRUCTION.

The materials of the buildings examined by the board were very numerous, and variously worked. They were generally and properly such as the vicinity of the house afforded, bricks being generally used where no stone was at hand. Some of the towers were of cut-stone, some of cut and rubble, and others of rubble; the latter predominating, and, when well put up, answering all the purposes. Some of the beacon-towers are constructed of wood.

Tide-light towers, and for beacon-lights, employed for rangers or leading marks in crossing shifting bars, should be, as a general rule, built of wood, and placed on skids or wooden railways, to admit of their being moved as necessity requires.

PROCURING MATERIALS AND SUPERINTENDENCE OF TOWERS AND OTHER NECESSARY BUILDINGS WHILE UNDER CONSTRUCTION.

Under this head the board refers to another part of this report for a full discussion of the subject, by their committee, composed of the two engineer officers, serving as members.

SECURING THE FAITHFUL OBSERVANCE OF CONTRACTS.

The board is of opinion that great pains have been taken in drawing contracts, and insisting upon their execution. Professional advice is, however, essential to security on this point. A knowledge of the qualities of stone, cements, mortars, and other materials used in their construction, is not to be acquired in a day, and belongs only, as a general rule, to a competent engineer, architect, or builder.

This is equally applicable to the construction of light-boats, beacons, and their accessories.

Thousands of vessels are built annually by persons fully competent to construct vessels for coasting, bay and river navigation, but who would be greatly at fault in the laying down and constructing, upon proper principles, a light-boat to be placed in an exposed open sea position. The ability required to design a perfect sea-boat, to cross the Atlantic under sail or steam, is equally necessary to design and construct a vessel to be placed at anchor off the bay of New York, South shoals of Nantucket, or, as in England, at the Saltees, Leman and Ower, and Goodwin sands, &c., &c.

That our light-vessels have not been modelled and constructed by the ablest naval architects, is a fact which the vessels themselves will prove.

CONDITION OF TOWERS AND OTHER BUILDINGS.

The best masonry which the board examined, was in the old tower of Sandy Hook light-house, built in 1762; the light-house tower of Cape Henlopen, built in 1764; and the Cape Henry light-house tower, built in 1791. The best modern towers seen were the one of cut-stone on Robbins' reef (wood-work not so good,) and the harbor-light tower at Newport, built under the direction of the Engineer Bureau of the army. Among the worst towers visited by the board, were the two at Navesink, Beaver-tail, Delaware breakwater, (built in 1849,) Cape May, (built in 1847,) and Cape Henlopen beacon. (Vide notes of inspection, appendix.)

The towers of most of the seacoast lights are too low. The greatest height being sixty-five feet, (see letter of general superintendent of lights,) it seldom happens that a proper location can be found sufficiently elevated, with so low a tower, to give a sufficient range to a first-class light; and on our low southern coasts, where there is seldom a greater elevation than ten to twenty feet, and in many cases not more than five feet above the highest tides, this elevation is totally inadequate.

A light placed on a prominent cape or point should be not less than 150 feet above the mean sea-level, to enable the mariner to be warned of his danger in time to shape his course, with the least loss of time, for his destined port; or in the event of bad weather, to haul off with comparative safety. Should there be dangerous rocks or shoals off this cape or point, then it becomes necessary to take this additional element into the calculation. A light placed on a coast of not sufficient elevation and power to be seen to seaward of hidden rocks and shoals, *is not only useless, but is, in itself, an element of danger to the navigator*, who, supposing it can be seen beyond them, may be led into the "trap." From an elevation of fifteen to twenty feet above the sea-level, a light one hundred and fifty feet high may be seen from nineteen to twenty nautical miles in the ordinary state of the atmosphere, provided the illuminating apparatus is of the best description, and properly placed and attended.

One of the most serious evils discovered by the board, in examining light-house towers, &c., was the many leaks in the lanterns and towers themselves, which tended greatly to the injury of the apparatus and of the light, and the rapid deterioration of the building. The lanterns were found, in general, to be too small, and too heavy; the astragals, in most instances, being so enormously large as to destroy much of the light from the lamps by interception. The interior of the lanterns, with few exceptions, was without paint, and very rusty; or, if painted at all, black, to the great injury of the light. The lanterns being of wrought-iron, necessarily require much more paint, care, and attention, and more frequent renewal, than the better metal, (bronze or gun-metal.) The rain, dew, &c., running down from the top of the upper part of the astragals of a wrought-iron lantern, become discolored, and leave on the glass of the lantern deep stains, which are difficult to remove, and which absorb much of the light in its passage to the horizon.

Ventilation is scarcely known in any light-houses visited by the board. Those intrusted with the lights seemed to be perfectly ignorant of the first principles of combustion and illumination. In some of the lanterns, while the lamps were well trimmed, and in other respects well cared for, there was so great an amount of carbonic acid that it not only prevented the

lights from burning clearly and brightly, but it affected the breathing of those who were present. The ventilators, as a general rule, were not only badly contrived, and in some instances not easily used to advantage, but were either permanently closed or never opened at all. The evidences of bad combustion, and consequently waste of light and oil, were apparent also in the quantities of soot in the interior of the lantern and dome. The reflectors and glass chimneys in many lights were smoked to such a degree as to render the latter injurious to the lights, and to the great permanent injury of the former. Leaky and badly ventilated lanterns, and the want of curtains to protect the apparatus when the lights are not lighted, tend greatly to the rapid deterioration of the illuminating apparatus and machinery employed in our light-houses. Constant and large repairs are required annually; and in spite of the large sums thus expended, the apparatus is not creditable to the country, and to the present state of science and the mechanic arts.

The tanks for oil are not fitted with the care and attention which the service demands. The oil, for want of proper under-ground cellars, is kept on the lower floors of the towers, with an occasional exception of the cellar of the dwelling of the keeper. Both places are equally bad; oil should not only be kept in a temperature which would always insure a perfectly fluid state, but it should not be placed where it could, by any possibility, be subjected to great extremes of heat and cold.

Another remarkable defect in all the light-house towers visited by the board, was the want of store-rooms for supplies, other than oil; wicks, chimneys, cleaning-powder, rags, and skins, are kept in places which forbid the possibility of keeping them free from sand and dirt. The bad condition of many comparatively new reflectors, attests this fact. Spare articles are thrown together, without regard to the character or quality of the articles, and greatly to the injury of them.

The frequent necessity for repointing the towers, (the materials and mechanics being necessarily, as a rule, brought from a distance,) is an evil, which can only be remedied by the introduction of a better system of repairs.

The keepers' houses are, with few exceptions, in bad repair; having been originally badly built, are a constant demand on the government for large annual repairs. Many of these buildings are comfortless, and ill adapted to the purpose for which they were designed. The remedy for this evil is only to be found in a system, which will place engineers of respectability and capacity where, now, contractors alone are held responsible.

The light-boats visited by the board afforded very little to commend. The one off Sandy Hook was clean, and in every respect in good order. One of the five boats visited had no one aboard but a negro boy; and another, placed in a most important position, had neither the master nor mate on board. These vessels were not in good order, generally. The apparatus, which has been spoken of elsewhere in this report, is of the rudest and most inferior description, affording lights comparatively valueless to the navigator, at a large annual expense.

The forty-two light vessels now in existence, if necessary to commerce, (and the fact of their being in existence in conformity to law is sufficient evidence of it) require to be fitted with parabolic reflectors and Argand lamps.

This might be accomplished, in part if not wholly, by taking the largest and best reflectors now in our sea-coast lights, for that purpose, and sub-

stitute the lens apparatus for them, as proposed; (see programme for lighting the entire coast—a part of this report;) by which means two essential objects would be accomplished at once, and at the expense of only one, and at the same time introduce an economy of four to one in all the sea-coast lights thus renovated, if the point be conceded that no first-class light ought to be left with one keeper; but if that point be contested, contrary to the experience and good sense of all the rest of the maritime world, then at a very great saving, with the additional keepers and lights equal to the demands of the times.

Many of the lanterns are yet fitted with small glass, imperfectly made, and placed in frames of enormous weight, with vertical astragals of width and thickness out of all proportion to the proper size for the required strength.

The glazing, as a general rule, is badly executed with putty alone. This mode has been abandoned long ago, in all well-managed European light-houses. The superiority of the diagonal astragal, and, as a consequence, the triangular panes of glass, is found not only in the advantage of more nearly equalizing the light, but also in the increased stability of the framework, rendering more slender bars equally effective.

No means or appliances are found in our light-houses for replacing, at once, broken panes of glass. A broken pane of glass, during a stormy night, in a light-house without the proper means of replacing it, might, and in all likelihood would, be productive of the most serious consequences. Panes of glass glazed in frames, and padded with cushions, should be in readiness, at all times, in the light-rooms of every light-house on the coast. With these “storm panes,” only a few minutes are required to replace those broken with the force of the elements, or by sea-fowl.

To prevent too rapid condensation of the heated air, double domes are essential. The best material for lanterns, is copper for the domes, (which should be double) and gun-metal for the astragals. These important points in light-house engineering are not known, or carried out, in this country, practically, although essential to the existence of good lights, and never overlooked in this branch of the public service in other countries.

The interior of light-house lanterns and domes should be kept perfectly clean, and painted with the clearest white paint. This operation should be repeated as often as necessary, to keep them white.

The ventilators should be so constructed as to enable the instructed keeper to regulate the quantity of air necessary for his lights, without difficulty. The best form is that of the circular register.

For reflector lights, each lamp should have a copper tube, (Farraday's) so fitted as to come down over the top of the glass chimneys, with the upper end leading into a large copper ball, through which the heated air and gases escape, and thence through the top of the lantern.

These tubes have been found to increase, to a small extent, the consumption of oil, with a greatly increased brilliancy of light. The expense of them would be paid for, in a brief space of time, in the saving of paint for the interior of the lantern, and of glass chimneys alone; as the whole of the smoke and gases are carried off through them, and at the same time the flames are kept so steady as to produce a great saving of chimneys.

In dioptric lights a ventilator and regulator are employed, having for its advantages the same results.

Stoves, oil-heaters, and frost-lamps for lanterns, are extremely objection-

able, and should never be employed, except in cases of absolute necessity, and that necessity should be determined, alone, by the engineer of the light-house establishment.

FLOORS; LIGHTNING-RODS; WEATHER-COCKS, &c.

The floors, in the towers, are generally of the roughest material, and such as renders it almost impossible to keep them in proper order. In attaching the lanterns to the towers, sometimes over soapstone floors, and sometimes over pine plank covered with sheet copper, but little professional skill has been exhibited. Disastrous leaks and heavy repairs are the consequences.

Lightning-rods are too often found neglected, and in such a manner as to render them dangerous, instead of a protection to the buildings. In some cases they are found to be broken off far above the ground; in others, in contact with iron bands around the towers, and more frequently lying on the ground, without any one, attached to the building, knowing the object for which they were placed there.

The vanes on the tops of the light-house towers, having to perform the important office of conducting the smoke and gases arising from, too frequently, bad combustion in our lights, should be fitted with great care and attention. This, however, is not the case. The dome being single, and the vanes badly fitted, the rain, and frequently the high winds, drive down into the lantern, causing the lights to burn badly and injure the apparatus.

PERFECTION AND IMPERFECTION OF THE ILLUMINATING APPARATUS.

On this subject, the board is constrained to say that the illuminating apparatus of this country is generally imperfect of its kind, and of a kind which has been abandoned, to a great extent, all over maritime Europe, and is gradually becoming obsolete everywhere.

The consideration of the systems of illumination of France, Great Britain, and other countries of Europe, where modern improvements have been introduced, or are gradually introducing, will prove that reflector lights are being abandoned for better and more economical systems.

Good reflectors, of the kind and form used in the best conducted lights, reflect but about one-half of the light which is thrown upon them. Imperfect ones much less.

On one of the newest reflectors which the board examined, the silver was not over $\frac{1}{432}$ of an inch thick, and was not firmly fastened to the copper. The surfaces, if irregularly formed, are soon scratched by rubbing with tripoli powder, which is supplied to the light-keepers for the purpose of cleaning the reflectors.

The shapes of many of the reflectors are not parabolic, and the portion of the parabola, in other cases, is taken at random, instead of being regulated by the divergency required for the light. The light is not in the focus of the paraboloid, and, in many cases, has a movable position from night to night. Some of the reflectors are so thin, that if originally of good figures, they could not be expected to retain them. The depth of Boston light reflectors, of 21 inches diameter, made by Wilkins, London, is 8 $\frac{7}{8}$ inches; those at Bald Head light, made in Boston, are 12 inches.

Adequate pains are not taken in their construction, so as to permit exact adjustment in position, upon which much of their efficiency depends. If adjusted originally, they cannot retain their position, being removed for cleaning, and having no adequate provision to insure that, when replaced, they will be precisely in adjustment.

Much of the difficulty of adjustment may be obviated, by introducing reflectors fitted with Mr. Alan Stevenson's lamp, and a code of carefully drawn up instructions to light-keepers, who should be well drilled in the use of the apparatus, by a competent person. (See description of Mr. Alan Stevenson's sliding-lamp, in Senate Doc. No. 448, first session twenty-ninth Congress; and also in his rudimentary treatise on light-houses; and in his description of the Skerryvore light-house, &c.)

The lamps and burners of the lights are nearly as various in pattern as the lights themselves.

Tin fountains are common, requiring frequent repairs, and often leak so badly that the keeper cannot keep the floor of the lantern free from oil.

Some of the more modern lamps are made of brass; are heavy, and apparently durable. The important point of regulating the flow of oil by a proper cut-off, has not received the attention which it deserves; the tilting process, destructive to the usefulness of the light, is often resorted to by keepers, to diminish or increase the flow of oil. A lamp made upon proper principles, and thoroughly tested afterwards, will never require to be removed from its horizontal position.

The burners are made of iron or brass, and in some cases of both; that is, in some instances there were found to be caps of iron, to be taken off and put on, the lower part being of brass. This plan produced galvanic action in the two metals, and consequently rapid deterioration. The burners are both too heavy and too thick. Much of the useful effect is lost by the imperfect combustion induced by this heavy burner. The best and most universally approved burner for Argand lamps is that made of tin, and tipped with silver. This burner is believed to be much more economical than the cheaper and more common ones.

While the deterioration of light is evident from the thick iron burner, its superiority is equally apparent from the thin tin burner. Universal experience in Europe, and in domestic concerns everywhere, attest its truth.

The Argand burners are generally greatly neglected by the keepers, not having been taught the necessity of keeping the tube for the interior current of air as clean as possible: they seldom scald the lamps to clear them of carbonized wick, gummy oil, &c.; consequently the lights become dim in proportion as they are neglected in this respect.

Instructions are required for trimming the lamps, elevating and turning down the wicks, regulating the flow of oil and the like, nothing of which is understood by the keepers in this country.

Proper trimming-scissors are not furnished, although essential to the proper performance of the duty.

Among the older lights, the lamps and reflectors are firmly fixed to a movable circular frame or chandelier. They are placed too far apart on the frame to produce a powerful and concentrated beam of light, while it not unfrequently happens that many of the reflectors *face towards the land or iron door of the lantern*. Those more recently fitted with apparatus, are so arranged as to allow the lamps and reflectors to be placed nearer to, or farther from each other, as the keeper may think proper, both vertically

and horizontally. Notwithstanding this latter arrangement, the reflectors are in almost every instance too far apart.

The frame or chandelier is made to revolve in consequence of the contracted dimensions of the lantern, to enable the keeper to bring the lamps and reflectors to him to clean, instead of having to walk around the apparatus. The frame being movable is a serious evil, as the keepers, as a general rule, set the frame by guess, and very seldom twice precisely in the same position.

There is no system, nor are there any written or printed instructions, for cleaning the illuminating apparatus; keepers use their discretion entirely in this as in almost all other matters which they may do well or ill, without the fear of any rebuke.

The tripoli furnished for cleaning the reflectors is not fit for that purpose. Reflectors cleaned with this powder must become inefficient very soon. Silver can be cleaned properly only by the use of the best whiting and rouge. Tripoli is used for *brass work*, elsewhere than in our light-house establishment.—(See Instructions to Light-Keepers of Great Britain, appendix.)

The cost of reflectors, lamps, &c., is small compared with that of the oil used in them, which is a daily expense, and true economy requires that *if reflectors are used at all, they should be of the best quality*. The difference in cost of the best silvered 21-inch reflectors, and a common 14-inch one, such as is used in some of our largest lights, is, according to the present contract by the general superintendent, about \$40, the interest on which is \$2 40, which is equivalent to fifteen nights' consumption of oil for one lamp. Imperfect reflectors give inefficient lights. It is easy to lose 20 to 30 per cent. of light in this way; requiring ten lamps to do the work of seven or eight, and consuming one-fifth to one-third more oil therefore, nightly, in the operation.

The very great economy and efficiency of the lens or Fresnel lights, as contrasted with the reflector lights, will appear in the course of this report. It amounts to a gain of at least three and a half (3.6) to one, on an average, when the two systems are equally well fitted and cared for, and in some cases to four times under similar circumstances; while under the present system, in this country, it is not doubted the saving would be much more in the aggregate.

CHARACTER OF THE VENTILATION.

The ventilation of the lanterns is of great consequence; for if the carbonic acid produced by the lights in burning is not carried off, it is not only injurious by taking the place of so much oxygen, but positively prevents combustion. A light will go out in a mixture of common air and carbonic acid, when a very considerable proportion of oxygen is present. The carbonic acid prevents perfect combustion, and the smoke interferes with the passage of the light, which is at the same time enfeebled in its brilliancy.

It has already been stated that the ventilation of the lanterns of our lights is very imperfect. (For further evidence, vide letter of the general superintendent of lights, &c., appendix C, No. 4.) Trap and other doors to the lanterns, can never afford proper ventilation. Strong currents of air under some circumstances may be produced by them, but not a uniform

one, such as the lights of a light-house require.—(Vide letter of Prof. Faraday, &c., appendix K, No. 10.)

In one of the light-houses visited by the board, which was otherwise well kept by a careful and worthy man, the ventilation was so imperfect that respiration was affected, and of course the lights were deficient in whiteness, which is the result of perfect combustion. Simple rules upon these and other points are required for the instruction of the light-keepers. They should also be practically taught their business for a time, and a certain amount of knowledge should be required of every man who undertakes such a trust—one involving in its execution, *according to knowledge, not only property but human life. Faithfulness without knowledge, will not suffice.* It is a great mistake to suppose “the trimming and cleaning of a small Argand fountain lamp are so simple and self-evident, as to be safely left to the intelligence of the meanest capacity.”—(Vide letter of general superintendent of lights, &c., appendix C, No. 4.) On the contrary, the board can readily understand that the general superintendent of lights, &c., has “had much inconvenience and difficulty to encounter from the frequent changes * * * * in the light-house keepers, who, for a time, do not understand the management of their lamps, and consequently keep bad lights and waste much oil.” (Vide letter of general superintendent of lights, June 7, 1851, appendix C.)

GENERAL POLICE AND REGULATION OF THE ESTABLISHMENT, CLEANLINESS, &c.

There are no general police regulations for the lights of this country. The only instructions to keepers are embraced in nineteen lines of ordinary type; merely specifying the time of lighting and extinguishing the lights, directing that the lanterns, lamps, and reflectors are to be kept constantly clean and in order, &c., and that the lamps are to be trimmed every four hours. That these simple requirements are not carried out, is evident from the notes of inspection appended to this report. (Vide appendix A, No. 2, &c.) The instructions to keepers of the floating lights are in every respect similar to those for the lights on shore, with the addition of three articles relating to the care and preservation of the vessels. (Vide appendix, Instructions; and also appendix, Rules and Regulations of Scotch, Irish, and Trinity House lights, with those for the port of Liverpool.) A reference to the instructions for the lights of Great Britain, France, &c., will clearly show the necessity for similar ones for this country, and the proper means to enforce them rigidly. The mere nominal annual inspections of the lights by the collectors of customs is productive of no good. The keepers know about what time to expect these visits, and are better prepared than at other periods of the year, to receive them; besides, it is impossible that the collectors of the customs can have any knowledge of illuminating apparatus and its adjustments. These visits are very short, never extending over an hour or two; rendering it impossible that beneficial results could accrue to the establishment from this mere nominal inspection.

The fact that the police and general regulations of the light-house establishment, *if such can be supposed to exist at all, are exceedingly defective*, is too apparent to need more than the bare assertion. (Vide the extracts from the reports of officers of the navy, and others detailed from time to time to inspect light-houses; including the report of Jonathan Howland, master of the oil vessel: Ex. Doc. No. 14, 1851.)

In reference to this subject the board would refer to the following extracts from Congressional Documents, which have a direct bearing upon it :

In House Doc. No. 811, 27th Congress, 2d session, the committee say :
“ In the opinion of the committee there should be established a plan of inspection more efficient. Frequent visitations, and minute examinations by competent inspectors, would insure vigilance, economy, and order, on the part of the keepers. The inspectors should be men thoroughly acquainted with all the details of light-house management and superintendency, with the manner of adjusting the lamps and reflectors, and of keeping them in good order.”

“ The collectors, acting as superintendents, cannot possess that information and practical knowledge necessary to a perfect administration of the system. The mode of conducting it has formed no part of their studies. They lack both theory and practice.”

In a report made to the Senate by the Committee on Commerce in 1838, (Senate Doc. No. 428,) it is said : “ The lights should be visited by a general inspector, who is master of the whole subject ; being fully capable of estimating the true character of the apparatus, its condition, the manner in which it is managed, whether the keepers are capable and faithful, and whether the oil is such as it should be.” “ In short, this visitor should be so thoroughly skilled, in every thing pertaining to the subject, as to keep the light-house in as perfect a condition as the arts and the progress of science will allow.” Again : “ We have already said that certain collectors of the customs are the inspectors of light-houses in their respective districts.” “ It is manifest the two offices have no natural connexion, for they require qualifications quite different. The one should understand the laws of light, as it is affected by reflectors and refractors ; the other the character and value of merchandise : and there is no affinity between the employments ; nor does it follow that one who is well qualified for a collectorship has a particle of that information which is essential to a well conducted system of lights.” Again : “ The number is great ; the duty is merely collateral ; their visits are seldom ; and their attention little engaged in the matter. They have no control over the system ; have no knowledge beyond their districts ; and the consequence is, that their inspection is generally of little importance, and has but little tendency to expose the faults or improve the character of the system. Indeed, so necessary is some other inspection, that the contractors who furnish oil are required to review and report upon the condition of each light ; and so also are the immediate keepers.” “ The subject was early committed to the collectors, as a matter of convenience ; but we may well inquire now, whether its importance does not call for a more skilful supervision ; one that can give harmony and character to the whole system, and make it not only keep pace with the progress of population and business, but with the advancement of mechanical and scientific improvements.”

The committee (Doc. No. 811, 2d session 27th Congress) say further :
“ In the opinion of the committee these views are entitled to the respectful consideration of Congress.” “ The appointment of inspectors, whose duty it shall be to devote their entire time, under the direction of the general superintendent, to frequent examinations of the light-houses, light-boats, buoys, &c., would be attended with no great increase of expense. The amount now paid to the collectors acting as superintendents is about eleven

thousand dollars. There is already attached to the establishment a small vessel."

The foregoing arguments appear to the board to be unanswerable, and embody all that they could say on this very important branch of the subject.

REGULARITY OF LIGHTING AND EXTINGUISHING, AND MODE OF SECURING IT.

This important branch of the light-house service is left wholly in the hands of the keepers.

In few instances, only, did the board find the keepers contending that they had carried out the instructions to light at sunset, and extinguish at sunrise. The execution of this part of the service faithfully and punctually, is one of great consequence, independently of the principle involved, which cannot recognise any discretion on the part of the keepers, in this or any other branch of the service. It is, in itself, important to the navigator that the lights should be lighted punctually at sunset, and not extinguished before sunrise; but *if the keeper is to decide as to the necessity or not of so doing, he may decide, if it suit his convenience*, (and one instance, at least, has been known) *during fogs, gales, or other conditions of the weather, to turn down the lamps so low that the lights would be totally useless, under the most favorable circumstances of weather*. It is during fogs, in heavy gales, &c., that it becomes the duty of the intelligent and faithful keeper to exert himself most, to keep up a bright light. Stringent regulations in detail, under frequent inspections by competent persons, can only remedy this evil—one that increases daily under the present management.

The want of inspections places the keeper above all authority, inasmuch as there are very few persons who are willing to volunteer to perform the ungracious task of finding fault with his neighbor, and possibly his friend, when in all likelihood, if he were public-spirited enough to do so, his motives might, and most probably would, be impugned.

MODE OF PROCURING AND DELIVERING SUPPLIES, AND OF TESTING THEIR QUALITY.

This important subject has not been fully and clearly explained to the board. The communication of the general superintendent of lights, &c., June 7 and July 3, 1851; the communication of the collector at Boston, (the actual purchaser of supplies) and that of Jonathan Howland, master of one of the vessels employed to deliver the articles of supplies, are not as satisfactory as the board could have wished. (Vide appendix C, Nos. 1 to 19.)

It is very evident to the board that the employment of the terms "*competent person*" in relation to the testing of oils, apparatus, &c., &c., and also in the construction of the latter, *is too vague and indefinite to be worthy of implicit credence, or to carry with it much weight*.

In the Trinity House corporation of London, the important subjects of experimenting upon different descriptions of combustibles for light-houses, testing the mathematical perfection of apparatus, investigating the important subject of ventilation, &c., are confided to *the world-renowned Michael Faraday*; upon the subject of construction and its accessories, Mr. James Walker, a distinguished civil engineer, is employed. In Scotland the lights and other aids to navigation are under the immediate direction and super-

vision of the able and distinguished engineer, Mr. Alan Stevenson. In Ireland, also, the lights are in charge of a competent engineer, (Mr. George Halpin, jr.) In France the admirable system commenced by Augustin Fresnel, the distinguished savan and academician, was carried out by his worthy and distinguished brother, Léonor Fresnel, who placed it, five years since, in the hands of his friend and associate in the "Ponts et Chaussées," the learned and accomplished Reynaud.

To expect that our lights should compare, in point of excellence and economy, with systems so constituted as these named, would be to expect order out of anarchy and confusion, and perfection out of such various and imperfect elements.

The article of oil, the most important in the list of supplies, should undergo the most rigid inspection, test, and scrutiny, before being received for use in our light-houses. There is no article of commerce more easily adulterated, and no article of supply, for lighting purposes, so necessary to be of the best quality; the existence and usefulness of the lights, depending mainly upon its good quality. The present habit of procuring two kinds of oil, "*summer* and *winter*," is extremely objectionable. The difference in price (judging by the contract) is very small, while by this mode a door is opened to the introduction of an inferior article, difficult to detect, and ultimately productive of much evil. The lights are only visited once a year by the supply vessel; and, as nearly as can be estimated, the quantity of oil, &c., &c., is left. The quantities of the two kinds of oil to be left, *are decided upon by the master of the vessel*. The keeper has no means of knowing "*winter*" from "*summer*" oil, and therefore is compelled to take the word of one who may be interested in the article. When bad oil has been left (a circumstance of very frequent occurrence,) *the keepers have been compelled to use it, however bad the lights produced by it were*. The collectors acting as superintendents, as a general rule being very far from the lights, could not remedy this evil wholly, under the present system; but if it were otherwise, the collectors have no authority to act except in cases of extreme necessity.

There should be but one kind of oil used, and that should be of the best quality. So long as we persist in using a more expensive and more easily adulterated oil, for our lights, than the rape-seed or colza oil now used universally in France and on the continent of Europe generally, in England, Scotland and Ireland, it becomes the duty of those charged with the management of our lights, placed for the protection of life and property, to discard all false economy and cause the best article that can be procured to be furnished to our lights. Every door to fraud should be closed. A scientific person of known ability, and of high moral and social standing, should have the duty confided to him of testing and receiving all combustibles, apparatus, &c., for light-house purposes.

Among the articles of light-house supplies, that of glass chimneys was most defective. They were irregular in shape, size, length and thickness. This, too, is a branch which, at first blush, might seem so simple that it might be comprehended "by the intelligence of the meanest capacity." However, such is not the fact. If they are too short, there is not sufficient draught, and consequently imperfect combustion. If irregular in shape, the flame is liable to approach nearer one side than the other, causing unequal heat, and consequently breakage. If unequally thick, they do not become uniformly heated throughout, and breakage is the necessary

consequence. The quality of the glass, too, is an important item, for upon it depends whether much or little of the emitted light is absorbed.

It has been ascertained by experiment, by the French light-house commission, and by others, that a particular shape for these chimneys is the only proper one. The model for the manufacture of them is preserved at the central light-house workshop, in Paris, and sent thence to those who furnish them. Before being received from the contractor they are all rigidly inspected, and then, on the least defect in color, shape, or quality of the material, are refused.

The next most important article of light-house supplies is the wick for lamps. Upon the material of which they are made, whether loose or close, &c., also depends the efficiency of the lights. This subject seems to have attracted very little attention in the management of our lights. The beautiful specimens of chimneys and wicks for the different kinds and orders of lamps and lights, sent to the board from the "Commission des Phares," by their secretary engineer, Mr. Reynaud, when compared to the many inferior articles in use in our light-houses, show at once the little attention which has been paid to this important branch of the service in this country.

It may be remembered, at the same time, that one of our glass establishments received a gold medal for a specimen of superior glass sent to the World's Fair in London last May, which is of itself sufficient evidence that we can produce such an article at home as the service demands. For reflector lights, the cleaning-powder and buff-skins are important items, and upon the good or bad quality of them the durability and usefulness of the apparatus greatly depend.

The "tripoli" powder, found in our lights, was gritty, and unfit for cleaning silver. Many of the reflectors seen by the board bore strong evidence of this fact. Various articles of this kind are employed in foreign light-houses, but it is believed that pure whiting and rouge are the only articles adapted to this special service. Proper places should be fitted for keeping these articles, in each light-house tower; which is not the case now.

Spare lamps, burners, &c., should be made to conform to the articles in use in the respective light-houses. Reflectors of different sizes, shapes, and qualities, burners of different sizes and thicknesses, all tend to produce a light of unequal intensity in the different azimuths.

The present mode of delivering light-house supplies is objectionable. The short time spent at each light by the master of the vessel, forbids the possibility of an adequate execution of the duties confided to him—those of repairing the apparatus, especially. (Vide Notes of Inspection, appendix A, No. 2, &c.)

Taking the prices contained in the printed estimates as a guide, the articles furnished to the different light-houses are of an inferior quality. No lists of articles for the lights are kept. Different lights are furnished with different articles, and in different quantities. No discretion should be left in these important matters of detail to any one. Lists, containing a necessary number and quantity of each article, for each class of light, should be printed, and each keeper should be furnished with them. The person charged with the delivery of supplies should examine the book of expenditures which each keeper should be required to keep; see that all the articles

not expended are properly accounted for, and in good order, and all deficiencies supplied, to the extent of the allowance list.

Extraordinary consumption should be inquired into, both for very small and very great expenditures. Very small expenditures afford evidence of bad light; while extravagant ones may be the result of improper application of the stores.

Supplies should be delivered more frequently. This course would tend to correct abuses and evils, which, under existing circumstances, can find no efficient remedy. For lights near large cities, difficulties arising from the supply of bad articles can be comparatively easily remedied; but at isolated and distant points, on a sparsely settled coast, it is almost impossible to do so by a single annual visit from the collector, and from the supply-vessel, which happen about the same time on nearly the entire coast.

Instead of, as now, employing on the Atlantic coast two sailing-vessels, for nearly the entire year, in making one visit to each light, the same service could be much more effectually and economically performed by a small steamer, which could visit every light on the entire Atlantic coast three times during the year; thus affording the keepers opportunities of making known their wants and complaints, and at the same time exert a salutary influence upon the keepers, by pointing out defects in the management of the establishments.

PURCHASING AND DELIVERING SUPPLIES, TESTING, &c.

This branch of the light-house service is, in the opinion of the board, so contrary to true economy and the interests of commerce, that they cannot too strongly urge the necessity for a thorough change. The experience in this branch, in France and Great Britain, may well be brought to our aid. (Vide letter of M. Léonor Fresnel, Senate Doc. No. 488, 1st session 29th Congress, and appendix H, No. 2, of this report; also letter of Jacob Herbert, esq., &c., appendix H, Nos. 8 and 9.)

MODE OF PROCURING THE SERVICES OF PROPER PERSONS AS KEEPERS.

The salaries paid to the light-keepers render the offices subjects of competition; and if skilful and competent men are not procured, it is not the fault of the department by which these compensations are fixed. The appointments are either made or recommended by those collectors who are superintendents of lights, in the different collection districts. The degree of general intelligence, and special acquaintance with their duties, activity and interest in their occupation, manifested by different light-house keepers at the stations visited by the board, was very various. In general, much interest was shown, and in a few cases much mechanical ingenuity.

The frequent changes in the persons employed, not resulting from neglect of duty, or want of qualification on the part of the incumbent, are necessarily very injurious to the efficiency of the light-house service.

In some branches of our public service examinations have been resorted to, with the happiest effect, in testing the qualifications for entering the service, and in subsequent promotions. In some foreign countries meteorological and tidal observations are required of the light-keepers, to secure adequate intelligence for the position, and to insure due diligence in the execution of all the duties devolved upon them. There would be a positive and

direct gain in efficiency, if the first system were introduced; and the use of the second would promote, incidentally, the same object. There is quite time enough for making such useful observations; and the moral effect would be to greatly elevate the office in the minds of many, who only view it now as an easy berth for the needy, or for those who are incompetent to perform more laborious service.

MANNER AND FREQUENCY OF INSPECTION—PERSONS BY WHOM MADE.

All experience shows that frequent inspections of light-houses are essential to maintaining an efficient system. These inspections, by competent persons, (engineers of the corps of Ponts et Chaussées,) are carefully provided for in France; by members of the Trinity Board in England, and by the engineers of local establishments, such as that of the Port and Bay, of Liverpool; and by the engineers and their assistants, of the establishments of Scotland and Ireland. (See appendix H.)

The vigilance which is secured by inspections at irregular intervals, is of greater value than even the direct results of an examination. Our system, at present, is quite deficient in this respect; a single annual visit from the collectors, who are superintendents of lights, and the visit of the employee who delivers supplies to the light-houses, &c., (the latter, in some districts, being the only inspection,) is obviously insufficient. (See Senate Doc. No. 428, 1st session 29th Congress.) The evident state of preparation in the light-houses at which the visits of the board were expected, showed that good effects would flow from a system of inspection.

Such a system could be organized with very little if any additional expense to the government; which will be discussed in detail in another part of this report.

The efficiency which would be gained by thorough inspection would justify additional expenditure, if it could not be reached without it; but it is believed to be clearly demonstrated, elsewhere in this report, that the present annual expenditure for commissions on purchases, distributing supplies, and nominal inspections, *would be ample*, under the system proposed by the board, to produce these desirable and beneficial results. *Better have fewer lights and effective, than many without efficiency.*

In the district of New York the collector employs an assistant, who is charged with the care of the lights, beacons, buoys, &c., and who has under his charge a small vessel for furnishing supplies, visiting the lights, replacing buoys when displaced, and the like. The zeal of this gentleman has been serviceable in the management of this district; and were it guided by good instructions, and sustained by occasional visits of a competent general inspector, would produce still better results.

DIRECTION AND MAKING OF ANNUAL REPAIRS, AND THEIR SUPERINTENDENCE.

System, in all these points, is indispensable to efficiency and economy, and should be combined with a good system of inspection. At present it is at loose ends, the usages varying even in the same district. In many cases repairs to buildings, wharves, &c., are postponed until decay has made such ravages that considerable expenditures are required, for what would have cost but little if applied at first.

The repairs of the lighting apparatus are generally only made when the

supply vessel visits the light-house; that is, once every year, and then frequently, as was stated to the board, *in a hasty and imperfect manner*. When articles are unavoidably procured from the nearest town or city, they are often of a kind ill-adapted to the purposes intended, or unlike, in size, figure, or material, the articles regularly supplied.

Considerable economy, in small matters, would result from a regular system of applications for repairs, of authorizing, supplying, and supervising them.

DETERMINING POSITIONS OF BEACONS, BUOYS, SEA-MARKS, &c., PLACING AND REPLACING THEM.

As a general rule, only seamen familiar with hydrography, and pilots, know what beacons, buoys, and sea-marks are required, and where and how they should be placed. The beacons, buoys, and sea-marks which would suffice for pilots, with their accurate knowledge of natural and artificial objects available for safe navigation, are not always sufficient for mariners generally. Their object is *not to dispense with the service of the pilot, but to furnish him with marks, &c., to provide for cases of emergency, when the vessel must enter, and may not be provided with a pilot*. Small coasting vessels, carrying freights which do not pay well, cannot afford to pay pilotage.

The necessity for the beacons, buoys, and sea-marks recently and at present provided for by law, is inquired into and reported upon by the superintendent of the coast survey, on the examination of officers of the work, and by the chief of the Topographical Bureau. They are then usually placed by pilots or seamen, but sometimes by the officers of the coast survey. When required to be removed on account of ice, or for repairs, or when displaced, they are replaced by contract by the year, under the authority of the local superintendent. The duty of replacing buoys, driven from their moorings, is neither superintended nor executed in a proper manner.

The buoys are usually placed by pilots (who contract to perform the service) by compass bearings, ranges, or by guess; and it has been remarked by the surveyors, that in many cases their places are so much changed in different years, as to produce error and even danger. The coast survey officers place them by the known positions of three suitable objects on shore—a method known as the three-point problem, measuring the angles with a sextant. This is the true mode of placing them, and no person should be permitted to put them down who is not competent to use that instrument. When placed, it is indispensable that their position should be verified by a competent officer, that he should report in relation to them to the local or general superintendent, and that he should inspect their positions from time to time, and always when, by accident or design, they have been moved.

COLORING AND NUMBERING BUOYS.

Until the passage of the recent law, (1850,) in regard to coloring buoys, the local superintendents changed the colors at pleasure, often introducing the utmost confusion. No notice of such changes being given to the general superintendent, no changes could be made in the charts of the coast, and

the worst consequences might have resulted. Wise legislation has checked this; but it is still true, that the examinations of positions, colors and numbers, should be made by competent inspectors, and reported to the department. Plain as are the directions of the law (*vide appendix*) in regard to coloring and numbering buoys, there is known to this board one important port in which the provisions of the law have been completely misunderstood, so that a navigator running by the buoys must put his vessel, if of considerable draught, on the bar.

Sufficient care has not been bestowed upon the buoys generally, under the law of 1850. The paint used for coloring has not been, in any single instance that the board has seen, of the best quality. To carry out the design of the act of Congress, the red, especially, should be of the best quality of red lead; the black of the glossiest; and the white of the purest white. Spanish brown and dirty black are difficult to distinguish from each other. Such may be seen almost every where, along our entire coast.

The spar-buoys, being the most common in this country, *are inefficient*; difficult to give easily distinguished marks, or numbers; and from their peculiar shape, size, and improper moorings, are too often at such an angle with the surface of the water as to render them exceedingly difficult to be seen.

Can and nun-buoys are employed, but not to a great extent, and those used are much too small. The boat-buoys, used chiefly on the eastern coast, are very efficient.

In some of the rivers, barrel-buoys, equal in capacity to about a sixty-gallon cask, are employed. Iron buoys have been authorized, by special acts of Congress, for the Columbia river, rivers in Texas, Hatteras shoals, &c., &c. (*Appendix.*)

The moorings of buoys in the United States are, as a general rule, very defective. The weight of the blocks of granite, or sinkers of iron, and size of chains, are not sufficient.

For want of proper inspection, buoys frequently sink at their moorings, and part their chains. Too much care cannot be taken to guard against these casualties, especially in important channels; in rivers and on sand-bars, lodgments of this kind may destroy a valuable channel.

The important duty of raising and replacing buoys, should not be left to the discretion of contractors.

The kind of buoys required, their material, &c., should all be provided for, by competent persons. In regard to distinguishing them, the board will elsewhere make further remarks. *The numbers as now placed upon the buoys are very ineffective.* The law in regard to coloring and numbering them, however, is deemed all-sufficient. (*Appendix.*)

NOTICE TO MARINERS IN REGARD TO CHANGES IN LIGHTS, BEACONS, BUOYS, &c.

This is a subject which, in the opinion of the board, requires more attention than has ever been given to it in this country. *It is not sufficient to publish changes in a local newspaper. They should be published, as far in advance of the proposed change as possible, in all the leading commercial newspapers, nautical periodicals, and by placards in large type, with conspicuous headings, and distributed at home and abroad, at the custom-houses and offices of the different consulates.*

In making changes, they should take place *at the precise time designated, and nothing should prevent the perfect fulfilment of the originally pub-*

lished design. Changes of lights in light-houses, removal or placing of light-vessels, should never take place with less than six months' notice; a year's notice would be better. Should a light-vessel break adrift, although replaced within a few days, a notice of both facts should appear together *in the same papers, and on the same placards*, as the navigator might, otherwise, see the notice of the breaking adrift, and not the other, and thereby be deceived. *This is one of the most important branches of the lighting service, and one that can never be perfectly systematized without a corps of competent and efficient local inspectors.*

In this respect the Trinity House, Northern lights, Irish board, Liverpool dock trustees, &c. &c., are good models. Notices of proposed changes of lights, buoys, beacons, and of new lights, *are to be found in every part of the globe, and always placed where the navigator is obliged to go before leaving port*, (the clearance office, and at the office of the consul of his country.) The admirable system followed by these independent boards, in all the minute details of the service, for the benefit of commerce and navigation, cannot be too highly commended.

Those who have been around the world, and visited nearly every principal port it contains, never saw a notice to mariners, relating to any American light, except by chance, in some corner of a newspaper, and that probably a merely local one.

Changes arising from casualties should be published widely in the manner prescribed, and at the same time reported, by the local inspector, to the department.

No changes should be made except on the authority of the department, which should authorize at least six months' notice, in all cases of lights.

The looseness of the system in this country heretofore, in these respects, is proved by the fact, that although a circular was issued by the general superintendent of lights, &c., directing the collectors, acting as superintendents of lights, to report to the superintendent of the coast survey all changes in regard to lights, beacons, buoys, &c., that they might be placed upon the charts, *but one collector ever complied with the direction.*

Changes which otherwise *would be improvements, unless known to the mariner, become snares.* No list of beacons, buoys, or sea-marks, exists; no description of them can be obtained, except by a general visitation and inspection of them along the whole coast. Having failed to obtain the required information, efforts have been made by the board to procure this important information from the local superintendents, for the purpose of arranging a descriptive list of them. So far, only a few returns have been made, and some of these not full enough to carry out the design.

European light-house boards do not confine themselves to giving notice to mariners of proposed changes, &c., in their own lights, &c., *but they cause those in foreign languages to be translated, and as widely disseminated as their own.* The Trinity House corporation of London causes the notices relating to lights, &c., on the French coasts, as well as on their own, to be published in the commercial papers *in this country.*

CONDITION OF LIGHT-HOUSE STRUCTURES OF EARLY DATE, AS SANDY HOOK, COMPARED WITH MORE MODERN ONES, AND CAUSES OF DIFFERENCE.

The board have already stated their conclusions on this subject, in discussing the general condition of the light-houses; and have suggested the remedy for defective construction.

COMPARISON OF THE SYSTEMS OF LIGHTING IN THE UNITED STATES, FRANCE,
GREAT BRITAIN, &c.

To make this comparison intelligible, will require a brief notice of the light-house systems of France and Great Britain, with some remarks on the systems of other countries.

FRANCE:

The administrative matters relating to light-houses, though hardly such as it would be possible for us to follow, are, nevertheless, regulated with a system of order worthy of all commendation.

As with us, no light dues are exacted from shipping, but the light-houses are a direct charge upon the treasury, and supported by annual appropriations.

The question, shall there be a light-house at a particular point, is decided by a board consisting of naval officers, government engineers and scientific civilians.* The first decision settles that inquiry is desirable. The civil engineer of the department where the work is to be placed, reports his views, with plans and estimates for it, which are laid before the board by their secretary. If it now appears that the work should go on in the manner proposed, the details of construction and the estimates pass to the general council of government engineers, (Bridges and Roads; "Ponts et Chaussées;") and when approved, are constructed by contract, *under the supervision of the government engineers of the department*. These engineers also superintend all repairs of light-houses. In some cases local boards are required, first, to examine and report upon the necessity for a proposed light, before the subject is examined by the light-house board. The administrative details are in the Department of State, ministry of public works, under which the different persons referred to, serve.

The general arrangement of sea-coast lights, adopted on the report of Rear Admiral Rossel to the light-house board in 1825, is based upon two principles: that one light of the brightest class shall not be lost sight of until another is visible; and that such distinction shall be presented by the light, that a vessel on nearing the coast, without very gross error in the knowledge of her position, cannot mistake one light for another. Twenty-one nautical miles was adopted as the distance of visibility of the brightest lights, and three classes of distinction were admitted, viz: fixed lights, revolving lights showing a bright light, and an eclipse at intervals of a minute and at half a minute. By placing the fixed light midway between the two revolving ones, of the different kinds, and at a distance of forty-two nautical miles from each other, the essential condition of the system would be fulfilled. In applying this practically, it was, of course, so modified as to conform to the general features of the coast, and to the wants of navigation. Between these brightest sea-coast lights, others, of inferior power were arranged as required.

Every light is placed under the inspection of a person called a *conductor*, who visits it at least once a month, by night as well as by day, and is provided with the keys of the building and of the watch-room, so that he can enter at all times, without summoning a keeper. The resident engineer of

* Members of the Academy of Sciences of France.

the department inspects all the lights in his department at least once a quarter, and the chief engineer of the department once a year, and the secretary of the light-house board makes an inspection at least once in three years.

The light-house keepers are furnished with books, ruled, and with appropriate headings to the columns, to record the observations required of them.

Detailed instructions for light-houses and beacons are distributed, which direct minutely their duty.

Prior to 1822, Argand lamps with reflectors were used in the French light-houses. In that year, Augustine Fresnel put up the first lens light of his invention, in the tower of Cordouan, at the mouth of the Gironde. In 1825 the general adoption of the lens system was determined upon. In 1845 there were on the coast of France, not including the colonies, 151 lens lights and 47 reflector lights; *and nearly all of the latter were merely beacon-lights.*

According to Mr. Reynaud's statement,* not one reflector light will be left in 1852, in the class of lights of the first and second order.

Experience, then, has led to the substitution of lens lights for the others, except as small harbor beacon-lights, requiring a small arc of the horizon to be illuminated.

The mechanical lamp used with the lens light was the joint invention of Arago and Fresnel, combining the idea of Rumford, of a number of concentric wicks, according to the intensity and volume required for the flame, and the idea of Carcel of keeping the wick from burning rapidly, by making the oil overflow about it, by raising it with a pump, moved by clock-work.

Several kinds of mechanical lamps have, from time to time, been presented for examination and trial, answering, generally, satisfactorily; those used in some of the recent lights are called the "moderator lamp."

The repair of twenty-eight lamps of the first order lights, four of the second and thirteen of the third, amounted, in 1850, only to \$183 56.

Mr. Fresnel suggests† that if it be apprehended, that, on account of the distance of a light-house from the workshops, there may be difficulties in regard to the repairs of the mechanical lamp, the appointment of a mechanic as light-house keeper, and the supplying him with the necessary tools, will be a very simple remedy.

In the refracting light the diverging rays from the lamp are rendered nearly parallel, by passing through a glass lens. Several such lenses, forming the sides of a prism, surround the lamp, the light from which is thus refracted into a number of beams corresponding to the number of the faces of the prism, separated by dark angles.

If this prism be made to revolve slowly about a vertical axis, there will be alternations of light and darkness, as the beam from the face of the prism reaches the eye, or it is in the dark angle between the beams. The increase of the light to its greatest brightness, and the decrease again, will be gradual. A prism of eight sides, thus revolving in eight minutes, would show bright flashes at intervals of a minute, and eclipses at the same interval.

The lens is made of a number of pieces of glass, ground to the same

* Letter of M. L. Reynaud, engineer-in-chief, secretary light-house board, to Lieutenant T. A. Jenkins, secretary light-house board United States, July, 1851.

† Letter of M. Léonor Fresnel to Lieutenant T. A. Jenkins.

curve, and fitted closely together. The building up of a lens in this way, of separate pieces, has been carried to very great perfection, and the separate pieces composing it are of beautiful clearness, polish, and precision of form.

A drum of glass, cylindrical in its horizontal sections, and lens-shaped in the vertical direction, placed about a lamp which occupies its centre, will diffuse all around the horizon the rays falling horizontally upon it, bending towards the horizon those coming above or below the horizontal line from the lamp, furnishing a fixed light of equal brilliancy in every direction. A panel of glass, lens-shaped in the horizontal direction, being made to revolve about this, would give a bright flash as the axis of the lens passed any particular point; and several of these thus made to revolve, constitute a fixed light varied by flashes.

When the whole of the horizon is not to be illuminated, a reflector is substituted for the lens behind the lamp, so as to throw to the front the light which would otherwise be lost.

Not to lose the light thrown upward by the lamp, a series of glass prisms is so arranged as to receive the rays at the angle at which they are reflected, to throw them downward to the horizon.

Similar prisms, below the lamp, serve to prevent the waste of the light which falls below the lens. This application of totally reflecting prisms is claimed by Mr. Alan Stevenson, of Edinburgh.

There are four orders of lens lights, according to the range of visibility, determined by the volume and brilliancy of the flame; the first order corresponding to the greatest range.

The number of wicks of the lamps, and the dimensions of the whole apparatus, vary, accordingly, in the different orders. The third and fourth orders are subdivided into two classes, corresponding to the larger and smaller size of the apparatus. The dimensions of the lantern of the several orders, the number of wicks of the lamps, and other details, will be found in the table annexed.

Fixed and revolving white lights are used to give six characteristic combinations—the simple fixed light, the fixed light varied by bright flashes every four, three, or two minutes, the revolving light with intervals between the flashes, or between the eclipses, of a minute or half a minute. By introducing a red fixed light, alternate red and white flashes, and a fixed white light with red flashes, these combinations are extended to eight. Two fixed white lights, in separate towers, are used in a few cases for the sake of distinction.

The loss of light by a deep-red glass, is stated by Mr. Stevenson to be as high as eighty per cent. of the whole. A pink French glass absorbed but fifty-seven per cent., but the color of the burner was not very decided.

All parts of the illuminating apparatus for light-houses are supplied from a depôt and workshops under the immediate direction of the secretary of the light-house board.

The distance to which a light may be seen, its range of visibility, (called sometimes simply its range,) depends upon the brightness (intensity) of the light, its elevation above the general surface, and the greater or less transparency of the atmosphere. Some persons, too, can distinguish lights at a much greater distance than others. The range of a light, then, is not a sure test for comparing it with other lights.

The value (useful effect) of a light depends on its brightness and the extent of the horizon which it will illuminate. The brightness can be ascertained by experiment with the photometer, in terms of the light of a stand

ard lamp as a unit; the extent of horizon illuminated, by simple measurement in degrees, minutes and fractions. Hence the value of a light can be expressed in numbers: so many units of the standard lamp, multiplied by so many degrees on the horizon. If the light is not spread uniformly over the horizon, it is necessary to estimate its brightness at different parts, and the space over which it extends. The value for each portion being thus found, the whole value is easily deduced.

Theory will show how much of a light from a lamp can be thrown by a given lens, or mirror, in a particular direction; but as the degree of perfection of these instruments would vary the result considerably, recourse is to be had to experiment in comparing different kinds of illuminating apparatus. Very careful and often-repeated experiments have been made by M. Léonor Fresnel, late secretary of the light-house board of France, for the purpose of comparing the reflector and lens lights used in France. To appreciate them fully, it is necessary to follow the very minute details entered into, by measuring the brilliancy of the light in the various divisions of the horizon, and finding its total value, (useful effect,) in estimating the value from different parts of the apparatus, and the allowance to be made for loss of light from the construction of the lantern, &c.* Without such a scrutiny, however, the character of their author, as an experimentalist, is a guarantee for the accuracy of the results. They show the following comparison for lens lights of the different orders, and equivalent systems of reflector lights:

4th order, 2d class; economy $2\frac{1}{4}$ to 1 in favor of the lens light.

3d " 1st " " $3\frac{1}{2}$ to 1 " "

2d " fixed; " $3\frac{1}{2}$ to 1 " "

2d " revolving; " 4 to 1 " "

1st " fixed; " 4 to 1 " "

This table is given more in detail in the appendix M, No. 8. The combination of reflectors, to be equivalent to the 1st order lens, is such as has never been made. The average economy of the light itself is about $3\frac{1}{2}$ to 1 in favor of the lens system.

To render these deductions strictly applicable to practice, they should be made under the precise circumstances in which the apparatus is used; but as they would then be made in conditions unfavorable to accuracy, it is usual to assume that, in practice, the lamp is burning in the best way, and thus to make the comparisons. To render them strictly applicable to the lights of the United States, the oil, too, should be the same, and the manner of burning it the same; or, if different oils were used, each oil should be burned under the most favorable circumstances for it. These remarks, however, touch only the refinements of the case, and show the desirableness of experiments made with the actual reflectors, lamps, and oil in use in the United States, with the lenses and their lamps, the oil being the same.

The board proposes to make such experiments, and has obtained the sanction of the Treasury Department for so doing. In the mean time it will be quite safe to assume, in any comparative calculation, the results just stated, which, indeed, agree remarkably well with those of Mr. Stevenson for the Scottish lights.

The question of the relative economy of the lens and reflector lights,

* See report of Lieutenants Thornton A. Jenkins and Richard Bache, U. S. navy, to the Secretary of the Treasury, 1845.

depends upon the relative cost of the light-house adapted to them; of the illuminating apparatus; of the repairs of the building and apparatus; salaries of the keepers; cost of the oil, and incidental expenses. In France two keepers have always been employed for the larger lights; one or the other being required to be constantly on duty, so as never to leave the lights without attendance in the lantern or watch-room. With the new apparatus for the 1st order lights, in ordinary cases, three keepers are allowed, increasing the expense for salaries about one-fourth. With those of the other orders, there has been no increase, two keepers being allowed to those of the 2d order, and 3d order 1st class, using the mechanical lamp; and one to the 3d order, 2d class, and to the 4th order lights, using the ordinary fountain lamps with Argand burners. The light-house buildings are of the same cost, except that an additional room must be provided for the third keeper of the lens lights of the 1st order. The first cost of the lens apparatus is somewhat greater than that of the mirrors; but the great economy in consumption of oil, turns the scale entirely in favor of the lens lights; giving, according to the calculations of M. Fresnel, made upon the prices in France,* for a small light, an economy of nearly 2 to 1 in favor of the lens; and for a large light, (revolving light, 2d order,) an economy of more than $1\frac{1}{2}$ to 1. The interest on the first cost of apparatus, and the additional salaries, must make a large increase to counterbalance the large economy in the consumption of oil, which, in France, we have seen to be more than 3 to 1 in favor of the lens lights.

The same grade of intelligence and education is stated by M. Fresnel to be required in the keepers of the two kinds of lights. The care of the mechanical lamp, however, requires more mechanical tact than that of a common lamp; while the cleansing of the lens apparatus requires less time and care than the others.

The additional keeper of the large lights, and the providing of a second lamp in case of accident, is supposed to guard against the danger of the total extinguishment, for any considerable time, of the single lights, which is the weak point of the lens system. A very simple alarm is also provided, which, as soon as the overflow in the lamp ceases, rings a bell, giving notice of any derangement in the machinery, &c., for raising the oil. Mr. Stevenson causes this apparatus to keep a bell constantly sounding, and to stop when the machinery becomes deranged; believing that he better secures the watchfulness of the keeper thereby. On this question M. Fresnel gives this very decided opinion—after an experience of twenty-two years, sustained by the daily results of more than one hundred lenticular lights of the first three orders—“that they have been distinguished by the regularity of their service.”

The metallic parts of the lantern are made of gun-metal, (bronze,) the astragals being inclined to the vertical. The ventilation of the lanterns is carefully attended to. The domes are of copper, painted white inside. There is a lightning-conductor, of copper wire strands, twisted like a rope, to each tower. The keeper's house, and the cellars for oil, are generally detached from the light-house, when practicable.

The construction of light-house towers offers nothing for special remark, except that, as might be expected from the care used in obtaining plans for them, they are substantial and convenient, dry and well ventilated.

* Report of Lieutenants Jenkins and Bache, pp. 122, &c.

Oil of colza, (rape-seed,) expressed from the seeds of a kind of wild cabbage, (*brassica oleracea*,) is the only oil used in the French light-houses. The colza gives a very white light, and the oil does not readily thicken by cold.

M. Reynaud, secretary to the light-house board of France,* speaks of the results of comparative experiments on olive oil, mineral oil from bituminous schiste, hydrogen, and mixtures of oxygen and hydrogen, as having been unfavorable.

The oil is tested before being received, by burning for fifteen or sixteen consecutive hours in a mechanical lamp, when, if it burns clearly, and makes little or no crust on the wick, it is received. The oliometer is also used in the inspection.

At the principal ports a book is kept, in which masters of vessels may register their complaints in reference to the lights on the coast. Their remarks are examined, and inquiry made by the inspecting engineers.

Table of comparison of lens and reflector lights, for the experiments of M. Léonor Fresnel.

Order of the lights.	Class and character of lights.	Equivalent system of reflectors.		Value—useful effects.	Economy—economical effects.
		Number.	Diameter.		
			<i>Inches.</i>		
Fourth	Second class	12	13½	2 to 1	2¼ to 1
Third	First class	14	11	1.4 to 1	3½ to 1
Second	Fixed	34	20	1.2 to 1	3½ to 1
Second	Revolving	24	20	.....	4 to 1
First	Fixed	36	24	.....	4 to 1
					3.4 to 1

GREAT BRITAIN.

The administrative part of the British light-house system is so peculiar, having grown up irregularly with the expansion of commerce, that it does not require to be described in detail. The chief English lights are under the direction of the corporation of Trinity House, Deptford Strond, London; and the Scottish and Irish lights under commissioners. The expense of the lights is paid by dues collected from vessels of all nations, including England herself.

The British lights are divided, according to their power and position, into three classes—seacoast, secondary, and harbor lights.

* Communication to Lieutenant Jenkins, &c.

† Sideral or Bardier Marcet reflectors.

Each district in England has a local inspector, and the members of the Trinity House corporation also inspect from time to time. In Scotland, the engineer of the commissioners has the general superintendence of the lights.

Notices in regard to lights are given in several of the daily metropolitan papers, in periodicals perused by nautical men, and are posted at the custom-houses.

The lights of Great Britain are principally still reflecting lights, but the lens light has been introduced in many of the most important positions, and is gradually taking the place of the other.

Trinity House lenses, 1st order	-----	15
Do. do. 2d do.	-----	5
Do. do. 4th do.	-----	Number not known.

In Scotland, the proportion of lenses to reflectors is greater than under the Trinity House corporation.

Mr. Stevenson says: "The Board of Northern Light-houses are, excepting in a few cases, giving up the use of reflectors, and substituting either Fresnel or holophotal lights." (See letter of Oct. 15, 1851.)

Quite recently three new lens lights have been established in England, by the Trinity House board; three others, of the first, second, and fourth orders, respectively, have taken the place of reflector lights, and fourth order lenses have been introduced for harbor lights.*

The first lens light in Great Britain was established in 1835, at Inchkeith, near Edinburgh, under the charge of Mr. Alan Stevenson; the next at the Isle of May; and now the Scottish lights of the larger classes are gradually being converted into lens lights. The Trinity House, of Deptford Strond, introduced the first lens light in England, in 1837, at Start Point, in Devonshire.

Mr. Herbert says: "The hydraulic lamp is universally in use in the dioptric lights of the corporation of Trinity House, with one exception, (the South Foreland light,) where the light is shown from a Carcel lamp, the disadvantage arising from the use of which is the occasional derangement of the machinery."† In Scotland, the mechanical lamp is used with the lens lights.

When the ventilation of the towers is not complete, the introduction of Professor Farraday's ventilating tubes over the chimneys of the lamps has been found very useful. The consumption of oil is increased, but the light is also increased, and no flickering of the lamp can occur in the highest wind. These tubes are used in all the English light-houses under the Trinity House board.‡

The oil of colza is now *exclusively used in all the lights under the Trinity House board.*§ According to Mr. Stevenson, its light is a little more intense than that of spermaceti oil; the consumption for a given quantity of light about the same, whether the two be compared in a mechanical lamp or a common Argand lamp; it remains fluid at temperatures which would thicken spermaceti oil; the flame appears more steady, and hence the breakage of lamp-glasses is less than with spermaceti oil. It is furnished in

* Letter of Jacob Herbert, esq., secretary Trinity House board, London, &c., 1851.

† Letter from Jacob Herbert, esq., secretary Trinity House board, &c., to Lieutenant T. A. Jenkins, secretary light-house board United States, 1851.

‡ Ibid. § Ibid.

England at eighty-nine cents per gallon, which is forty per cent. less than the cost of spermaceti oil there.

The supplies of oil, wicks, glasses, &c., are delivered once a year by a vessel belonging to the corporation.

There are two distinctive characters given to the reflector lights on the Scotch coast, differing from those already adverted to; in one, by placing the rims of all the mirrors on one side of a revolving light, in one vertical plane, and inclining their axes slightly to the horizon, and causing a rapid rotation of the frame, a flash is produced every five seconds, which appears to rise and fall; the bright and dark intervals follow each other rapidly. In the other, an intermittent light is produced by the vertical motion of circular disks in front of the reflectors, eclipsing the light for half a minute, and then permitting it suddenly to show out.

In England, the cost of the lens apparatus for a seacoast light, lantern, and pedestal, exceeds that of the reflector apparatus nearly one-fourth; but this disappears in the cost of tower and apparatus, and the advantage is on the other side when the charge for construction is turned into an annual interest, and the cost of illumination is considered.

No difference is made in the number or salaries of the keepers of the lens lights in England. Two keepers are allowed to all large lights, because one is required always to be on duty in the watch-room.*

Comparing the value (useful effect) of the revolving lens light at Skerryvore, Scotland, with the old reflector light at Inchkeith, Mr. Stevenson makes it in the ratio of nearly $8\frac{1}{2}$ to 1, and the economy (economical effect) in the proportion of $3\frac{1}{2}$ to 1. Spermaceti oil was used in these comparisons, the result of which, as to economy, is the same as was obtained in France. In the comparison of fixed lights, Mr. Stevenson makes the economy of the lens light rise to four times that of the reflector. Taking the interest on first cost of erection as an annual charge, and combining it with the cost of maintaining the two kinds of lights, Mr. Stevenson makes the economy of the lens system, for *revolving lights of the first order*, to be as 1.2 to 1, and for large fixed lights as $1\frac{1}{2}$ to 1.†

Argand burners and parabolic reflectors are used in the British light-vessels, both for fixed and revolving lights. The lanterns are of copper, or of gun-metal.

There are from three to eleven light-vessels in each of the districts under the charge of the Trinity House board, and in each district a relief light-vessel is stationed. A gong is used as a fog-alarm, in the Trinity House corporation light-vessels.

The very ingenious apparatus invented by Mr. Thomas Stevenson, and called, from its rendering the whole of the light effective for illuminating purposes, "holophotal," will be found described in the appendix P, No. 2. A holophotal apparatus may be made entirely of glass, being composed of totally reflecting prisms, and of lenses. The hemisphere of rays thrown behind the light is reflected totally by a series of zones, the surfaces nearest the flame forming a dome, of which the flame is the centre, and, therefore, not altering the direction of the reflection. The rays thus reflected forwards are received by the same lens and totally reflecting prisms, which give the appropriate divergence to the rays thrown forwards from the lamp.

* Letter from Jacob Herbert, esq., to Lieutenant Jenkins.

† Stevenson's Skerryvore Light-house and Illumination of Light-houses—1848.

The lens system was early introduced into Holland, where it has been entirely approved; it has also been introduced into Sweden, Denmark, Prussia, and Russia. The colza oil is also in common use. There is no case where the lens lights have been introduced, in which recurrence has been made to the reflector system.

From these data, we are prepared to make the comparison required by the instructions of the department, under the heads which it has pointed out, as far as it can be done without further experiments.

The use of these data will be entirely safe, since the systems of reflecting and refracting are compared under the most favorable circumstances for each class.

1st. *Useful effect*.—We have just shown that, by the experiments of Fresnel and Stevenson, the useful effect of a lens light is to that of a reflector light of the same class, on the average, as $3\frac{1}{2}$ to 1; of course, the holophotal system of saving some of the lost light in the various arrangements, increases this disparity.

2d. *Economy; first cost; repairs; durability; efficiency*.—This branch of the subject has been so elaborated elsewhere in this report, that it is considered only necessary to remark briefly upon it in this place.

Assuming that the lights in the two systems are the best of their kind:

The economy of the third order lens light, in comparison to the reflector light, as nearly equal to it as possible, is as 1 to 2.6. That is, it requires more than two and a half times as much oil, &c., for the reflector light, which is less than one-third as useful, as for the lens light.

The economy of the second order lens light, in comparison to the reflector light, as nearly equal to it as it is possible to be made, is as 1 to 4.07. That is, the lens apparatus is four times as advantageous as the reflector light.

The economy of the first order lens light, compared to that of the reflector, is 4.08 to 1; or that the reflector is four times as expensive as the lens, or that the lens is four times as advantageous as the reflector light.

“That if we take into account the first cost of construction and the expense of their maintenance, we will find, in respect to the effect produced, the new system (dioptric) is still from one and a half to twice as advantageous as the old.”

The repairs to the mechanical lamps employed in lens lights, amount to a mere nominal sum.—(See letter of M. Reynaud, appendix H, No. 2.)

No difficulty can be anticipated in getting proper keepers to attend to the lens lights. Men belonging to the class of ordinary mechanics or laborers, are appointed to take charge of the lights in France. Eight or ten days will suffice to instruct a light-keeper in the most essential parts of his duty, receiving lessons from an instructor conversant with all the details of the service.

The attendance upon the lamps can no longer be regarded with fear of ill consequences. They have been greatly improved, and are now believed to be nearly perfect.

There is nothing belonging to a mechanical lamp which could not be repaired by a watchmaker, and any person capable of taking charge of a movable light is equally competent to manage a lens light.—(Vide letter of M. Léonor Fresnel, appendix No. 1, H.)

While experience has fully proved that the fears which were entertained of the extinction of the single lamp used in the lens lights are illusory, yet

should they still exist in any mind, and greater guarantee be absolutely required than experience gives, it would be easily afforded by furnishing each of the three or four wicks of the mechanical lamp with a separate pump, rendering them thus, in effect, three or four lamps. By subdividing the wicks, this might, if desired, be carried still farther, and the expense of the additional pumps would not add two dollars per annum to the cost of each first-class light.

The experience in relation to lenses has not been confined to any one country; even in our own, with but three stations, the results are most conclusive in their favor.

The board is of opinion that every first-class light should have two keepers, as in Great Britain, &c. Such, however, is not the case in the United States; and in making the comparison of cost, they have deemed it best to allow the salary of an assistant keeper, and the additional cost of his dwelling-rooms, in making comparative estimates of the expense of the lens and reflector lights; but in comparing the actual annual expense of lights per lamp in this and in foreign countries, no credit was given to the foreign light for having additional keepers, and no charge made to our lights for deficiency of keepers.

The Committee on Commerce (Mr. J. C. Clarke reporter, May 25, 1842, H. R. No. 811, 2d session 27th Congress) say :

“It is not believed that dioptric lights of the first order can be required at any points except a few, and those the most important outer sea-stations. The remarks hereinafter made in regard to the comparative efficiency and economy of French and American lights, and the letter of the Auditor, may suggest doubts of the propriety of using any of the first order.”

First order lights are, if possible, *more necessary on our coast than on that of any other country, and the board cannot, therefore, conceive what good reason could be given for not introducing them.* It is true, we have no first order lights at present, but many are claimed to be of that class, while they are no better than third-class ones. It is demonstrated elsewhere in this report, *that the first order lenses are absolutely necessary; and it is beyond question true, that no combination of the reflectors can produce a first order light equal in power to a first order lens.*

Again, the committee say :

“In arranging lights, useful effect and expense should be looked at in one view. An outer or seacoast light should have a ‘portee’ or reach of light sufficient to give the approaching vessel, in all weathers, timely notice of danger. Any expense in fitting up lights to produce more effect is useless. A light extending its limit of visibility to the distance of twenty-five miles, is as efficient and useful as one of greater range. The mariner sees it in ample time to shape his course, free from all difficulty.” The board concur in these opinions. *But our lights are not of that character.* The object of a light is to warn the navigator of some hidden danger, or of his approach to land, and to guide him clear of that danger on his way, or into his destined port. It therefore becomes necessary to regulate the power and range of a light, solely with reference to these primary objects. If a light is placed on a “clear coast” merely to warn the mariner of his approach or proximity to a lee-shore, or of his danger of running his vessel on it at night, a power and range must be given with reference to the gradual or irregular soundings in approaching the danger. If it is intended to serve as a guide around a dangerous point or shoal, then it becomes

necessary to give it such a range as will insure safety to the vessel outside of these dangers under every circumstance; such, for example, as a sudden storm, or a continued gale blowing on shore for many days.

There are many points along the coast of the United States, with dangerous shoals extending many miles from them. To guide vessels clear of these dangers, lights of the greatest power and range are indispensable. Take as example the Nantucket shoals, those between Barnegat and Cape May, off Absecon, and those off Capes Hatteras, Lookout, Fear, Romain, &c. The shoals off Cape Fear extend twenty nautical miles from the present light, which can only be seen under favorable circumstances about twelve miles. The necessity for first order lights at all points where sea-coast lights are required, is therefore indisputable. None of the lights named above have a sufficient range to warrant the mariner in running boldly for them. The lights on the Bahama banks are vastly superior to those on the Florida coast. The idea that our lights are injured by the haze, mists, &c., &c., arising from the proximity of our southern coast to the Gulf stream, is therefore erroneous. (See letters of hydrographic officers of coast survey, in appendix.) That there is nothing in the atmosphere along our coast calculated to effect the brilliancy and power of good lights, which does not exist on the coasts of England, Ireland, Scotland, France, Holland, Denmark, Norway, Sweden, &c., &c., is abundantly proved by the observations of intelligent individuals, who are acute observers of meteorological phenomena, and who have had their attentions drawn to this particular subject in consequence of the great inferiority of our lights, compared to those of the rest of the maritime world.

The proper elevation to be given to first-class lights, is a subject closely allied to, and in some degree dependent upon, the general state of the atmosphere in the vicinity of the particular lights.

Observation by intelligent professional persons, will always enable the light-house engineer to act understandingly and decide correctly in all special cases of this kind.

As a general rule, it is considered by able light-house engineers in Europe, that on coasts where fogs prevail, a light should not have a greater elevation than 200 feet above the mean sea-level; but under other circumstances any elevation, if desirable to afford a greater range to the light, may be given, which is not above the region of clouds. (For tables of heights of the principal sea-coast lights in England, France, this country, &c., &c., see appendix M, No. 6.)

RELATIVE ECONOMY OF REFLECTOR AND LENS SYSTEMS.

Cost of the gradual introduction of the Fresnel or of the Holophotal system, carefully ascertained and compared with the present system, say in a period of five or six years, in regard to useful effect and economy.

For this purpose let us commence by taking Sandy Hook light, fitted with 18 twenty-one inch reflectors, found by comparison with the Navesink lens light of the second order, in the proportion of 1 to $6\frac{1}{2}$ in useful effect.

Reported consumption of oil, 1850, (Senate Doc. No. 14.,

2d session 31st Congress)----- 661 gallons.

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Reported consumption to light-house board, (see notes of in-

spection, 1851,) 195 gallons per quarter----- 780. "

United States estimate----- 630 "

European estimate----- 720 gallons.

The mean of the keeper's reports for two years is the European estimate within half a gallon----- 720½ "

Take, then, as a just quantity, 720 gallons per annum.

By placing a second order lens light in the Sandy Hook tower, which could be done without increasing the dimensions of the lantern, or elevating the tower, there would be a saving of 336 gallons (or 720-384) of oil per annum, which, at \$1 30 per gallon, will be \$436 80. Supposing that the other supplies would be in the proportion of 1 to 18, and making a proper allowance for the difference in price of the glass chimneys for the lens lights, omitting cleaning-rags, &c., &c., upon which there would be undoubtedly a great saving, there would be an additional saving of \$22 78 per annum, or a total saving by the change in one year of \$459 58, with a lighting apparatus which would never require repairs, and cannot wear out; of a power six and a half times greater than the present reflector apparatus, which requires to be renewed frequently—say once in ten to fifteen years, at least.

The economical effect will be, for reflector, as at present----- \$964 35
 " " " lens ----- 504 77

or nearly as two to one.

All first and second-class lights, whether lens or reflector lights, require two keepers. An additional keeper, at \$360 per annum, would nearly cover the saving in money, it may be said; but still, the sum paid to the present keeper, above that allowed to other keepers, would be saved, as the necessity for this increase would cease the moment a proper keeper is appointed as an assistant; or, \$150 + \$99 58 = \$249 58. Thus we should have a light six and a half times better than the present one, fitted with an imperishable apparatus, save \$249 58 in money per annum, besides the price of eight extra burners complete, and eight extra outside burners, left last year, (the cost of which is not known) and have a competent keeper always in attendance upon the light at night.

The same comparisons may be made with Cape Henlopen, Cape Henry, and Cape Hatteras lights, with the difference that first order lenses are required at these very important points. Cape Hatteras, the most important one, having only fifteen, while the other two have eighteen reflectors each, consume, respectively, 720, 720, and 600 gallons of oil when properly kept. A first order lens light consumes 570 gallons of oil, making a saving of 330 gallons in these three lights.

It has been seen that the third order lens light at Brandywine shoal, having a range of less than sixteen miles, elevated forty-five feet, and seen from an elevation of ten to fifteen feet, is six times more powerful than the Cape Henlopen light.

The estimated value of useful effect of a third order lens, larger model, similar to the one at Brandywine shoal, is----- 1,400,000
 which has been shown to be six times better than Cape Henlopen light; therefore, the value of useful effect of that light is 233,333
 and the value of the light proposed as a substitute (first order lens) is----- 9,500,000

Therefore, the new light, consuming 150 gallons less oil per annum, will be forty-seven times more useful; or seven times more useful than the third order lens, already shown to be so far superior to it.

The same comparisons might be continued to the end of the list of our lights.

It may be useful to compare a few of the smaller lights; and as an example, the Lazaretto light, near Baltimore, may be taken. There are eleven lamps and *spherical reflectors* in this tower.

Reported consumption last year, 431 gallons of oil.

Estimated consumption according to European standard-----	440 gals.
United States estimate-----	385 "

This light is required to light a harbor, and the entrance to it, of small extent; a visibility not exceeding five to six miles.

The first cost of the eleven lamps and reflectors, (which require to be renewed frequently) frame, fitting, &c., independently of spare lamps, burners, &c., will be not less than-----	\$350 00
Annual expense for oil, 431 gallons, at \$1 30-----	560 30
For chimneys, glasses, and wicks-----	12 30
	572 60
Extra burners, supposed not less than-----	5 00
Annual cost-----	577 60

independent of cleaning-powders, rags, &c., &c., not required for a lens light.

The first cost of a sixth order lens apparatus, which does not require to be renewed, with three lamps, (two being extra) and pedestal, &c., complete, estimating five francs to \$1, will be--	252 00
which is less than the first cost of the reflector light, by----	98 00

The consumption of oil per annum for the lens light will be forty-eight gallons, costing-----	\$62 40
For wicks and chimneys, say-----	1 50
	63 90

Thus, while the first cost of a sixth order lens apparatus, producing a far better light than the Lazaretto light near Baltimore, is \$252, and the first cost of the present light is not less than \$350, or in the proportion of 1 to 1.39, the annual expense is as \$63 90 for the lens, to \$577 60 for the reflector light—in the proportion of 1 to 9; or, in other words, the present inferior reflector light costs nine times more, annually, than the sixth order lens superior light would.

The comparison may be made with other lights of this class, more recently erected.

The two beacon-lights on Oak island (Cape Fear) built last year, are fitted with ten *spherical reflectors* and lamps each.

The apparatus for these two lights cost not less than-----	\$700 00
The annual expense for oil, &c., exclusive of extra burners, &c., is not less than-----	1,070 00
Two sixth order lens lights would cost, with extra lamps, &c., complete-----	504 00
Annual expense for oil and wicks, glasses, chimneys, &c.-----	127 80

The proportion in favor of lenses, in this case, will be \$504 to \$700 in first cost, or 1 to 1.39; and in annual expense \$127 80 to \$1,070, or 1 to 8.14; making the present reflector lights, annually, 8 $\frac{1}{4}$ times more expensive than the lens light would be at a large first cost, and produce far better lights.

The same comparison might be made with the two beacon-lights at Price's creek (Cape Fear river) recently erected, and pretty nearly the same results would be had.

The revolving light at Ocracoke, fitted with 10 twenty-one inch reflectors and lamps, might be advantageously changed to a fourth order lens light.

First cost of reflector apparatus not less than \$950 to \$1,000, say-----	\$1,000 00
First cost of a fourth order revolving lens light with revolving machinery, &c., and three lamps complete (two being extra ones) 5,005 francs-----	1,001 00

The first cost of the two may be considered, therefore, equal, while the superiority of the lens is undoubted.

The reflector light consumes, as reported (see Ex. Doc. No. 14, 2d session 31st Congress,) 467 gallons of oil per annum—at \$1 30 per gallon, will be-----	\$607 10
Tube-glasses and wicks-----	13 20
Spare lamps, about-----	11 00

Making annual expense for supplies-----	<u>631 30</u>
---	---------------

The consumption of oil for the lens will be 130 gallons—at \$1 30 per gallon-----	\$169 30
Tube glasses-----	1 25
Wicks-----	50

Total annual expense for supplies-----	<u>171 95</u>
--	---------------

Thus it is seen that while there is no difference in the first cost of the apparatus, the lens which never requires renewing, while the reflectors will not last usefully for more than ten to fifteen years, the lens will produce a much better light, and economically, in the proportion of \$171 95 to \$631 30, or 1 to 3.7 per annum. That is, the inferior light, costing the same amount at first, is nearly 3 $\frac{3}{4}$ times more expensive annually than the better light.

If it were necessary, these comparisons might be extended; as there are many of the bay, river, and harbor lights fitted with ten, twelve, and fifteen lamps and reflectors, which might, with great propriety, be changed to lens lights of the fourth order, if not, as it is believed, many of them might be changed, with propriety, to fifth and sixth order lights.

The light-tower with thirty lamps and parabolic reflectors, which is not equal to a second order lens apparatus for the upper, and the fourth order larger model for the lower light, in the same tower, may be stated as follows:

Consumption of oil for second order lens-----	384 gals.
“ “ fourth “ “ (larger model)-----	130 “

Total for the two lights, greatly superior to the reflector lights 514 gals.

Estimated consumption in the United States, per Argand lamp
35 gallons; for 30 lamps----- 1,050 gals.

Estimated consumption in Great Britain, where properly kept,
40 gallons per lamp----- 1,200 “

making a difference in the saving of oil in this tower, of 30 lamps, of 536 gallons per annum, according to the United States estimate, and 686 gallons according to the European estimate, which is believed to be nearest the truth, (judging from the returns of our own keepers) where the lights are properly kept. Supposing the oil to cost at the light \$1 30 per gallon; in the first case there is a saving of \$696 80, and in the latter case \$891 80. This light having an assistant keeper, no additional expense for keepers would be incurred by substituting the lens apparatus. But as this is an important seacoast light, it should be fitted with a lens of the first order.

The consumption of oil for a first order lens is, per annum 570
gallons ----- 570 gals.

The consumption of oil for a reflector light, as nearly equal to
a first order lens as it is possible to obtain one, (36 lamps)
at the estimate of 40 gallons per lamp per annum, will be 1,440 “

Making a difference in the annual saving of oil alone, of----- 870 gals.

Careful photometric experiments have proved that a first order lens is four times as economical as a reflector light of 36 lamps and large parabolic reflectors, and that the best reflector lights seldom equal the second order lens lights.

Thus, by substituting a lens of the first order for a reflector of the first order, there would be an advantage of 4 to 1, and the saving of oil alone, at the supposed rate of \$1 30 per gallon, delivered at the light, of \$1,131 per annum.

But, to carry the comparison still further; suppose it is necessary to have the present distinction of two lights in the tower preserved, and at the same time a first order lens for the upper light, and a fourth order, larger model, for the lower one:

It has been shown that the thirty lamps consume, per annum, according to the United States estimate, 1,050 gallons, and by the European estimate 1,200 gallons of oil.

The first order lens will consume----- 570 gals.

The fourth order lens, larger model----- 130 “

making a total consumption for the two lights, of 700 gallons per annum. Difference between the present light (*inferior to a second and fifth order lens*) and the first order and fourth order lens, taking the smaller estimate of this country, will be 350 gallons of oil; or, according to the European

estimate, to 500 gallons of oil; and in money, \$455 or \$650 per annum, and the useful effect of the light will be in the proportion of about 1 to 10.

The light of twenty-nine lamps, which is not equal to a second order lens, consumes, as estimated in this country, 1,015 gallons of oil per annum; and according to the estimate in Europe, 1,160 gallons per annum.

A second order lens light consumes 384 gallons per annum; making a saving in that article alone of 630 gallons, according to one estimate, and 776 gallons per annum according to the other estimate; or in money, \$820 30, or \$1,008 80.

The difference in the intensity and usefulness of the light would be, assuming the reflector light to be unity, 1 to 4; or, in other words, the lens light would be four times as advantageous as the reflector light. But, in this case, also, it is important that a first order light should be substituted for the present one. Therefore, the consumption would be 570 gallons for the first order lens, instead of 1,015, or 1,160 gallons for the present light, making a saving of 445 gallons, or 590 gallons; or in money, \$578 50, or \$607 70, per annum. This being one of the lights on the coast of the United States with an assistant keeper, no increase of expense would arise in that department.

There is a light with twenty-one lamps and reflectors, inferior to a second order lens, which ought to be changed to a first order lens.

Present estimated consumption, United States-----	735 gals.
European estimate-----	840 "
Second order lens consumes-----	384 "

Difference in favor of lens, 351, or 456 gallons per annum; and in money \$458 30, or \$592 80.

Here, also, a first order light should be substituted, for which 570 gallons of oil would be required, while the present inferior apparatus consumes 735 or 840 gallons per annum; making more than a sufficient difference in favor of the lens, to pay the salary of an additional keeper, while the first order lens light would be from five to six times more advantageous to commerce than the present one.

The remaining reflector lights would be greatly improved in brilliancy and useful effect <i>by changing them all to lens lights</i> . The consumption of oil for the 311 reflector lights, containing 2,880 lamps, according to the department estimate, would be-----	100,800 gals.
According to the European estimate it will be-----	115,200 "
Say at a cost, delivered at the lights, of-----	\$131,040 00
Or-----	149,760 00

It has been shown elsewhere in this report that the twelve best reflector lights of the United States are not equal to the second order lens lights; that there are ninety not equal to the sizes of third order lenses; and two hundred and five not equal to the fourth, fifth and sixth orders of lenses.

12 lens lights of the second order consume annually of oil-	4,608 gals.
96 " " " third " " " "	17,568 "
205 " " " fourth, fifth and sixth " " "	9,840 "

Total amount of oil necessary for all these lens lights-----	32,016 "
The four lens lights consume now-----	1,518 "

III I	Total for all the lights-----	33,534 "
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Present quantity appropriated for the lights of the United States in 1851-'52-----	108,255 gals.
United States estimate for reflector lights actually in existence, 2,880 lamps-----	100,800 "
European estimate for 2,880 lamps-----	115,200 "
Saving in oil by changing to the lens system-----	68,784 "
Ditto on European estimate-----	83,184 "
Annual saving in money, adopting the United States estimate at \$1 30 per gallon delivered-----	\$89,419 20
Ditto on the European estimate-----	108,139 20
Take the quantity estimated for-----	108,255 gals.
Deduct for lenses existing now-----	1,518 "
	106,737 "
Deduct for the 16 fourth order lens lights, and the 313 of the different orders-----	32,816 "
Will leave a saving of-----	73,921 "
Or, in money-----	\$96,105 10

Thus it is seen that instead of 108,255 gallons of oil, as at present required, the same number of lights, *superior in brilliancy and usefulness*, in the lens system, could be maintained with 32,816 gallons per annum. Hence there would be a saving in money (taking the mean of the actual quantities according to the United States and the European estimates, which is 75,984 gallons,) of \$98,779 20 per annum for oil alone, in favor of the lens system, throwing entirely out of view the cost of the difference of transportation, which would necessarily be in favor of the smaller quantity.

To this actual saving for oil of-----	\$98,779 20
Add the difference in favor of lenses between the cost of glass chimneys, repairs of lamps, chimneys and wicks, in the proportion of 309 to 2880, or 1 to 9, in favor of lenses. The appropriations of 1851-'52 for chimneys and wicks was \$3,129 30; saving with the lenses, of-----	2,816 37
Appropriation for repairs to lamps and reflectors in 1851-'52, \$12,183, making a saving with lenses, of-----	10,964 70
Total-----	13,781 07
Deduct from this sum the difference in price of glass chimneys for lenses, say-----	375 00
And there will be a clear saving of-----	13,406 07
To which add saving for oil-----	98,779 20
Total amount gained in one year-----	112,185 27

The estimates for whiting, buffskins, cotton cloth for cleaning-rags, and the amount gained in transportation of a smaller quantity of stores, are retained, under the presumption that little saving in these items would be made by the change.

Having shown that if, at a moment, all the lights on the coast of the United States fitted with Argand lamps and reflectors were changed into lights superior in nearly every instance in point of intensity, brilliancy, and range, to those now in use, by the introduction of the system of Fresnel, there would be an annual saving in money of \$112,185 27, out of an appropriation of \$152,081 59, or that the present system of lighting is more expensive than the Fresnel system in the proportion of 3.8 to 1; or, in other words, while the annual expenditure for oil, wicks, chimneys, cleaning-rags, repairs of illuminating apparatus, &c., as at present, amounts to \$152,081 59, if all the lights were fitted with the Fresnel apparatus, of equal in all, and in many cases greater power, than at present, the annual expense would only be \$39,896 32.

This annual saving of \$112,185 27 would be sufficient to enable the government, in five or six years, to have every light on the coast fitted with the lens apparatus, without costing one cent beyond the customary appropriations up to that period, and thenceforth to insure an annual reduction of the light-house expenditures for those stations to the amount stated.

In this estimate no allowance has been made for the value of the present apparatus; an item of considerable importance.

The wear and tear of the reflectors, which require to be renewed frequently, and the large expense of keeping the lamps and burners in repair, is at once got rid of; the proportion being, as has been already shown, in the ratio of 1 to 9. While reflectors require renewing, the lenses, in the language of Sir David Brewster, "*are perennial.*" If mere considerations of economy were to be taken into view, and the great cause of humanity and the interests of commerce to be thrown aside, it will suffice to say, that the first year's saving would fit up all the smaller (river, bay, and harbor) lights of the United States with lenses, which would prove to be the most economical step; as it is especially with these 8, 10, and 12-lamp-lights that the smaller lens lights are to be most favorably compared, in an economical point of view; the consumption of oil being in the ratio of about one-seventh, one-ninth, and one-eleventh; whereas in the large reflector lights the saving is from one-fifth to one-half and one-third.

Now, although the most decided results in favor of economy are to be expected from the reformation of the minor classes of lights, we do not, therefore, conclude that we should begin with them, because humanity, and the more general interests of commerce and the safety of our ships-of-war, have their claims. Our ships-of-war, vessels engaged in foreign commerce, all that arrive on our coast from distant voyages, are more liable to suffer from the inferiority of our seacoast lights, or higher class lights, than are our coasters, from the deficiencies of the inferior classes; and accordingly, it is along our exterior coast-line that we find occurring the greater number and the most disastrous shipwrecks during the stormy seasons.

The minor lights are usually so multiplied, and the localities inside of the general coast-line so well known to the navigators of our bays and rivers, that they cannot often be at a loss for a secure harbor somewhere in heavy weather; whereas the seacoast-lights, at times comparatively few, and even deficient in number, and at others complicated by their superabundance, occupy positions full of danger to the navigator. It is, therefore, of the first importance to ships arriving on the coast from distant voyages, that the light which they first make should be clearly visible at the greatest distance from the land, and that it should be so distinct in character as not

to be confounded with other lights; and it is not less important that we should not delay giving to such lights all the perfection they are capable of receiving; and having accomplished this purpose with respect to the most prominent and important, we should extend the improvement to the lights of inferior classes and of minor importance, although by so doing we were to save at the outset something less than if we were to begin by reforming the minor lights, because in the mean time our foreign commerce and the navy might be suffering to an amount far surpassing that which might be saved to the revenue.

Mr. Alan Stevenson (Treatise on Light-houses, page 121) says: "In comparing the fixed dioptric and the fixed catoptric apparatus, the results may be summed up under the following heads:

"1. It is impossible by means of any practicable combination of paraboloidal reflectors to distribute round the horizon a zone of light of *exactly equal intensity*, while this may be easily effected by dioptric means in the manner already described. In other words, the qualities required in fixed lights cannot be so fully obtained by reflectors as by refractors.

"2. The average light produced in every azimuth by burning one gallon of oil in Argand lamps with reflectors, is only about *one-fourth* of that produced by burning the same quantity in the dioptric apparatus, and the annual expenditure is £140 3s. 8d. less for the entire dioptric light than for the catoptric light.

"3. The characteristic appearance of the fixed reflecting light in any one azimuth, would not be changed by the adoption of the dioptric method, although its increased *mean* power would render it visible at a greater distance in every direction.

"4. From the equal distribution of the rays, the dioptric light would be observed at equal distances on every point of the horizon; an effect which cannot be fully attained by any practicable combination of paraboloidal reflectors.

"5. The inconveniences arising from the uncertainty which attends the use of the mechanical lamp, are not perhaps so much felt in a fixed as in a revolving light, because the greater simplicity of the apparatus admits of easier access to it, in case of accident.

* * * * *

"There can be but little doubt that the more fully the system of Fresnel is understood, the more certainly will it be preferred to the catoptric system of illuminating light-houses, at least in those countries where this important branch of administration is conducted with the care and solicitude which it deserves."

Mr. Alan Stevenson, the distinguished engineer to the Northern-lights commissioners, says further:

"The expense of fitting up a revolving light with twenty-four reflectors, ranged on three faces, may be estimated at £1,298, and the annual maintenance, including the interest of the first cost of the apparatus, may be calculated at £418 8s. 4d. The fitting up of a revolving light with eight lenses, and the diacatoptric accessory apparatus, may be estimated at £1,459, and the annual maintenance at £354 10s. 4d. It therefore follows, that to establish, and afterwards maintain a catoptric light of the kind called revolving white, with a frame of three faces, each equal in power to a face of the dioptric light of Cordouan, an annual outlay of

£63 18s. more would be required for the reflecting-light than for the lens light; while for a light of the kind called *revolving red and white*, whose frame has four faces, at least thirty-six reflectors would be required in order to make the light even approach an equality to that of Cordouan; and the catoptric light would, in that case, cost £225 more than the dioptric light."

Convert these two sums into our currency, and it will be seen that we have a saving in the first case of \$309, in the second case of \$1,089, per annum.

"The effect produced by burning an equal quantity of oil in revolving lights in either system, may be estimated as follows: In a revolving light, like that of Skerryvore, having eight sides, each lighting with its greatest power a horizontal sector of 4° , we have 32° (or *units*) of the horizon illuminated with the full power of 3,200 Argand flames, and consequently an aggregate effect of 102,400 flames produced by burning the oil required for *sixteen* reflectors; while in a catoptric apparatus like that of the old light at Inchkeith, having seven sides of one reflector each, lighting with its greatest power a sector of $4^{\circ} 25'$ we have nearly 31° (or units) of the horizon illuminated with the full power of 400 Argand flames, and consequently an aggregate effect of 12,400 flames as the result of burning the oil required for seven reflectors. Hence the effect of burning the same quantity of oil in revolving lights in either system will be represented respectively by $\frac{1}{7}$, $12,400 = 28,343$ for the catoptric, contrasted with 102,400 for the dioptric light; or, in other words, revolving lights on the dioptric principle use the oil more economically than those on the catoptric plan, nearly in the ratio of 3.6 to 1."

Let us, then, take the appropriation for oil for the lights in the United States, deducting the quantity used in the four towers fitted with dioptric apparatus, and divide it by 3.6, the proportion to 1, in favor of the lens apparatus.

1851-2—Appropriation for oil (less oil burned in lens lights)	\$122,629 25
1 to 3.6 will give necessary quantity for lens lights of equal power-----	34,063 68

Annual saving for oil by this mode of comparison -----	88,565 57
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Glass chimneys, wicks, and repairs of lighting apparatus, will be in the proportion of not less than 310 to 3,093; that is, 1 to 10.

Amount appropriated for these objects, minus the expenses of the same articles, for the four lens lights-----	\$15,162 30
1 to 10 will give the necessary expense with lenses-----	1,516 23

Annual saving by this comparison in these articles-----	13,646 07
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The oil being the most bulky article of supplies, it may be assumed that the saving in oil will be a fair proportion for the transportation, the more especially as spare lamps, burners, reflectors, and the great wear and tear of the Argand lamps, burners, and reflectors, is not included in the estimate of annual saving.

Amount appropriated for transportation and delivery of oil and other annual supplies, 1851-2-----	\$11,437 00
1 to 3.6 will give the necessary expense for this article-----	3,176 94
Annual saving with lenses-----	8,260 06

It may be urged that there would not be so great a saving in transportation by the change; of that, the experiment alone can decide.

By the aid of a small steamer, one-half of the amount appropriated could be saved in money, while very important additional service would be rendered in the way of inspections, and more frequent visits to the principal sea-coast lights.

Taking, then, the savings of this mode of comparison, it will be as follows:

For oil in one year-----	\$88,565 57
For wicks, chimneys, repairs of apparatus, &c.-----	13,646 07
For transportation-----	8,260 06
Total annual saving-----	110,471 70

Making within a fraction the same amount which would be saved annually by the introduction of the lens apparatus by this comparison, that was shown by taking the lights in their regular order of powers, and comparing them with orders of as nearly as possible equal powers in the Fresnel system. Nothing, therefore, can be clearer than the results thus set forth.

“The effect produced by the consumption of a gallon of oil in a fixed light, with 26 reflectors, which is the smallest number that can be properly employed, may be estimated as follows: The *mean* effect of the light spread over the horizontal sector, substituted by one reflector, as deduced from measurements made at each horizontal degree, by the method of shadows, is equal to 174 unassisted Argand burners. If, then, this quantity be multiplied by 360 degrees, we shall obtain an aggregate effect of 62,640; which divided by 1,040, (the number of gallons burned during a year in twenty-six reflectors,) would give 60 Argand flames for the effect of the light maintained throughout the year by the combustion of a gallon of oil.”

“On the other hand, the power of a catadioptric light of the first order, like that lately established at Girdleness, may be estimated thus: The mean effect of the light produced by joint effect of both the dioptric and catadioptric parts of a fixed light apparatus, may be valued at 450 Argand flames; which multiplied by 360 degrees, gives an aggregate of 162,000; and if this quantity be divided by 570, (the number of gallons burned by the great lamp in a year) we shall have about 284 Argand flames for the effect of the light produced by the combustion of a gallon of oil. It would thus appear, that in fixed lights the French apparatus, as lately improved, produces as the average effect of the consumption of the same quantity of oil over the whole horizon, upwards of *four times* the amount of light that is obtained by the catoptric mode, although in certain directions, opposite the axes of each reflector, the catoptric light is fully 50 per centum more powerful than the dioptric light.”

“But the great superiority of the dioptric method rests chiefly upon its perfect fulfilment of an important condition required in a fixed light, by distributing the rays *equally* in every point of the horizon.”

Hence, the saving for fixed lights in the same amount of oil, &c., appropriated for as before, will be-----	\$91,971 94
Saving on other articles-----	22,226 07
Total saving per annum-----	<u>114,198 01</u>

It may, and probably will be urged, that a large portion of this annual saving will be absorbed in the wages of additional keepers. In answer to that, it may be stated, that in the comparisons of reflecting and refracting systems in Europe, the same number of keepers is required for both, of equal class or order, and therefore the ascertained saving *is a net annual gain*.

In the United States, as a general rule, but one keeper (there being only 14 assistants belonging to an establishment of 301 light-stations, fitted with reflector apparatus,) is attached to a light-station. To render the larger, or sea-coast lights efficient and safe, two keepers should be attached to each station having a single tower, and three to those with two towers, whether fitted with reflectors or lenses.

However, as it may be contended, that inasmuch as our reflector lights in general have only one keeper, and that the change to the lens system would require two to each light of the first and second classes or orders, it may not be inappropriate to see how many of the present lights on our coast would be required to be changed, and the increased expense for an additional keeper to each. From the northeastern boundary to the Rio Grande there are 38 positions which ought to be fitted with the most powerful first order lenses.

There are points between some of these first order lights which ought to be fitted with second order lens apparatus, making a total of about 50 lights of the first and second orders. An additional keeper for each, at the rate of \$300 per annum, will be \$15,000.

If this sum be deducted from the total already shown, (which, on the contrary, ought to be added to the present expenditures, to render our lights in that department equal to European lights,) there will still be an annual saving of \$95,471 70, or \$99,198 01. If additional evidence were required to prove so plain a proposition, *that the reflector system is more expensive than the lens system in the proportion of 3.6 to 1*, disregarding the great superiority of the lens system for all the useful purposes of the mariner, it would be found in the action of the Trinity House corporation, of Deptford Strond, London; Northern-lights commissioners, of Edinburgh; and the Ballast Board, of Dublin, Ireland.

In 1835 the first lens apparatus was introduced into Scotland.

In 1837 the first lens was introduced into England, under the Trinity House corporation; and since 1845 the first lens light was lighted in Ireland.

Now (1851) there are very few lights fitted with reflectors in Scotland; the commissioners having abandoned the use of that apparatus, and substituted for it the Fresnel and holophotal system of Mr. Thomas Stevenson. (See appendix.)

The Trinity House (London) has upwards of twenty lens lights of the first and second orders, besides numerous fourth order harbor lights. Lens lights are also being introduced into Ireland; the precise number, however, now existing there, is not known, as they are not marked in their printed lists, and no information has yet been received from that board.

It is worthy of remark, that these three light-house boards of Great Britain and Ireland, are close corporations, deriving their means entirely from light-dues levied upon the shipping of all nations, including that of their own. They derive no pecuniary advantages from the government, and are only under its general control; consequently their acts are independent of Parliamentary legislation.

If these boards had found the recommendations of the select committee of the House of Commons of 1845, to use less expensive apparatus and combustibles in their lights, with a view to the reduction of light dues, had not been based upon sound principles, they would have had no inducement to follow them; for whether the lights are economically kept or not, good or bad, the same amount of light-money would be collected. It is therefore plain that the introduction of the lens apparatus, and the colza oil, into the establishments under the control of these independent corporations, was the result of close examination and trial by those charged with, and most interested in the subject. The introduction after France, first by Holland, and successively by Belgium, Hanover, Prussia, Denmark, Sweden, Norway, Russia, Italy, Spain, Portugal, and Brazil, and the colonies of the respective nations, goes far to counteract any prejudice which may exist in any quarter, of the globe against this *inimitable* illuminating apparatus for light-houses.

Notwithstanding the renovations of English, Scotch, and Irish lights, and the erection of new towers, fitted with the lens apparatus, a material reduction has been made of late years in the light-dues levied in Great Britain upon shipping. This may in some degree be attributed to the increased amount of commerce and navigation, and the more frequent and rapid intercourse between nations, by the aid of steam navigation; but, *it cannot fairly be contended that it is wholly due to that cause.*

These facts are undoubted, and the deductions from them, it is believed, will, upon the closest scrutiny, be found to be correct.

Mr. Alan Stevenson says, (page 115, Treatise on Light-houses :) "It therefore follows, that, by dioptric means, the consumption of oil necessary for between fourteen and sixteen reflectors, will produce a light as powerful as that which would require the oil of twenty-four reflectors in the catoptric system of Scotland; and, consequently, that there is an excess of oil equal to that consumed by ten reflectors; or 400 gallons in the year against the Scotch system. But in order fully to compare the economy of producing two revolving lights of equal power, by those two methods, it will be necessary to take into the calculation the interest of the first outlay in establishing them."

It is worthy of remark that the French were followed by the Dutch government in introducing lenses into their light-houses.

The subject of introducing lenses into the Scotch light-houses was brought before the commissioners of northern lights by the engineer* of that body, at the instance of General Colby, of the royal engineers, as early as 1824. The Scotch commissioners directed their engineer to visit France, and report upon the lights of that country. At the close of the year 1834, the board directed lenses to be imported for the purpose of making experiments. These experiments resulted in the recommendation that an important light should be changed from a reflector to a lens apparatus.

* Robert Stevenson, esq.

It is believed the powerful and unanswerable arguments contained in the letters of Sir David Brewster, in 1833, to the Bell Rock committee, (Northern-lights commissioners) in favor of lenses, contributed greatly to the early introduction of them into the lights of Scotland.

Notwithstanding the numerous experiments from 1825 to 1834, made by the Northern-lights commissioners to test the relative merits of the two systems, it was not until the latter year that decisive steps were taken to decide the question.

In October, 1835, the reflecting apparatus of the revolving light at Inchkeith was removed, and dioptric apparatus substituted.

So great was the satisfaction which this change produced, that another light was immediately changed to a lens light. The second lens light erected in Scotland was at the Isle of May, in September, 1836.

The Trinity House, London, fitted the Start Point light with a lens apparatus in 1837.

The Turkish government employed an English engineer in 1836-7, to make experiments with the Fresnel lenses, Drummond's light, &c., to enable it to decide upon the best illuminating apparatus for the Bosphorus from the Black sea. The letter upon this subject from William Henry Barlow, esq., which was read before the Royal Society of London, will be found to contain much valuable information for those interested in the experiments of light-house navigation.—(Vide Philosophical Transactions of the Royal Society of London, 1837, p. 211.)

NUMBER OF LENSES IN THE WORLD.

At the present moment, (1851,) there are lens lights of the three first orders (first, second and third orders) 216, and of the smaller classes 152; making the total number of lenses 368.

They are found now in England, Scotland, Ireland, France, Belgium, the maritime states of Germany, Denmark, Norway, Sweden, Russia, (the Russian government has a French artist established at St. Petersburg, for the manufacture of lenses for their lights,) Italy, Spain, Portugal, the Mediterranean, Egypt, Turkey, East and West Indies, Brazil, and, in general, in all the colonial dependencies of the European states. One first, two second, and one third order, are the only lenses at present in the United States.

The three first named were procured in obedience to special acts of Congress, and the third order was placed on the Brandywine shoal by the Topographical Bureau.

It is understood that the two light-towers now in the course of erection at Sand Key and Carysfort reef, under the direction of the Topographical Bureau, are to be fitted with first order lenses.

Mr. Stevenson pays this merited tribute to the distinguished savan whose system is now almost universally admired and adopted throughout the maritime world: "Fresnel, who is already classed with the greatest of those inventors who extend the boundaries of human knowledge, will thus at the same time receive a place amongst those benefactors of the species who have consecrated their genius to the common good of mankind; and, wherever maritime intercourse prevails, the solid advantages which his labors have procured will be felt and acknowledged."

RELATIVE ECONOMY OF THE UNITED STATES AND FOREIGN LIGHTS.

APPROPRIATIONS FOR LIGHT-HOUSES, &c., &c.

Approved August 10, 1846.

For 2,577 lamps, supplies, &c.-----	\$112,883 64
For 236 keepers' salaries-----	100,588 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	10,038 77
For annual repairs and alterations-----	67,077 99
	292,588 73

Annual cost of maintenance per lamp, \$113 51.	
For 30 floating lights-----	97,711 62
Annual cost of maintenance per light-vessel, \$3,257 05.	
For buoys and beacons, raising, cleaning, replacing, &c., &c.-	31,431 69
For new lights, &c., &c., &c.-----	24,800 00
Total amount appropriated for lights, buoys, beacons, &c., for 1846-----	446,532 04

Approved March 3, 1847.

For 2,594 lamps, supplies, &c.-----	\$113,478 64
For 238 keepers' salaries-----	101,538 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	9,812 82
For annual repairs, &c.-----	65,455 10
	292,284 89

Annual cost of maintenance per lamp, \$112 68.	
For 30 floating lights-----	85,669 48
Annual cost of maintenance per light-vessel, \$2,855 65.	
For buoys, beacons, &c., raising, cleaning, replacing, &c., &c.-	24,371 43
For new lights, &c., &c.-----	516,950 00
Total amount appropriated in 1847 for lights, buoys, beacons, &c.-----	919,275 80

Approved March 27, 1848, and August 12, 1848.

For 2,976 lamps, supplies, &c.-----	\$163,840 77
For 273 keepers' salaries-----	114,948 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	12,346 15
For annual repairs, &c.-----	78,889 67
	372,024 92

Annual cost of maintenance per lamp, \$125 35.	
For 31 floating lights-----	\$95,915 02
Annual cost of maintenance per light-vessel, \$3,094 03.	
For buoys, beacons, &c., raising, cleaning, replacing, &c., &c.-----	35,156 28
For new lights, &c., &c.-----	343,493 90
Total amount appropriated for lights, buoys, beacons, &c. for 1848-----	846,590 12

Approved March 3, 1849.

For 2,843 lamps, supplies, &c.-----	\$135,103 60
For keepers' salaries-----	116,198 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	11,673 25
For annual repairs, &c.-----	81,714 04
	346,689 22
Annual cost of maintenance per lamp, \$121 91.	
For 33 floating lights-----	102,236 65
Annual cost of maintenance per light-vessel, \$3,098 08.	
For buoys, beacons, &c., raising, cleaning, replacing, &c., &c.-----	29,677 46
For new lights, &c., &c.-----	281,598 37
Total amount appropriated for lights, beacons, buoys, &c., for 1849-----	760,201 70

Approved September 28, 1850.

For 2,110 lamps, and supplies, &c.-----	\$147,474 19
For keepers' salaries-----	127,448 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	12,253 60
For annual repairs, &c.-----	84,630 60
	373,806 72
Annual cost of maintenance per lamp, \$120 19.	
For 40 floating lights-----	93,140 77
Annual cost of maintenance per light-vessel, \$2,328 51.	
For buoys, beacons, &c., raising, cleaning, replacing, &c.-----	39,449 92
For new lights, &c., &c.-----	643,320 00
Total amount appropriated for lights, beacons, buoys, &c., for 1850-----	1,149,717 41

Approved March 3, 1851.

For 3,093 lamps, supplies, &c.-----	\$152,081 59
For keepers' salaries-----	127,003 33
For annual inspections-----	2,000 00
For commissions to superintendents for purchases, &c.-----	12,908 92
For annual repairs, &c., &c.-----	89,698 64
	383,692 48

Annual cost of maintenance per lamp, \$124 05.	
For 40 floating lights-----	\$108,565 24
Annual cost of maintenance per light-vessel, \$2,714 13.	
For buoys, beacons, &c., raising, cleaning, replacing, &c.---	37,008 02
For new lights, &c., &c.-----	256,735 00
Total amount appropriated for lights, buoys, beacons, &c., for 1851-----	<u>786,000 74</u>

Recapitulation.

Annual cost per lamp for 1846-----	\$113 51
do. do. 1847-----	112 68
do. do. 1848-----	125 35
do. do. 1849-----	121 91
do. do. 1850-----	120 19
do. do. 1851-----	124 05
For six years-----	<u>717 69</u>

Annual average cost per lamp for the last six years, \$119 55.

To this sum should be added the salaries of the numerous custom-house officers who attend to the duties connected with the lights, and who receive their salaries from a different appropriation.

The lights of the United States, with the exception of the lens lights at Navesink, Sankaty Head, and Brandywine shoal, and the reflector lights at Bayou St. John, Frank's island, Southwest Pass, South Pass, (Gordon's island,) Pleasanton's island, Cat island, Pass Manchac, Vermillion bay, Cape Florida, Turtle island, Egmont Key, and Execution Rocks, (twelve lights having assistant keepers,) have but one keeper each; while the rock lights (those in isolated positions) have from three to four keepers, and every sea-coast light not less than two keepers each, in all the countries of Europe and their dependencies.

Add the additional expense for an increased number of keepers to render our lights efficient in that department, and the annual cost per lamp, will be increased to an amount greater than the reported annual cost per lamp of the European lights.

The Trinity House (English) lights, being chiefly first-class sea-coast lights, (harbor and other local lights, and other aids to navigation, being under the control of the different local corporations,) cost per lamp per annum-----	\$142 88
Scotch, as above-----	133 50
Irish sea-coast lights-----	102 00
Irish harbor lights-----	118 00
United States, average for six years-----	119 55

The foregoing statement of the annual cost per lamp for maintaining the

lights of Great Britain and Ireland, prior to the introduction, by the light-house boards of that kingdom, of the large number of Fresnel or lens lights now in use, is found from the most reliable sources.

This mode of comparing the lights of other countries with those of the United States *is not fair*, inasmuch as, by it, the most powerful and best attended lights are placed on a parallel, in a financial point of view, with those *in every respect inferior to them*.

In this estimate all the lights of the United States are included, from the pier-head, with a single lamp on it, to the largest and most important sea-coast light; on the contrary, the English and Scotch lights are generally sea-coast lights, fitted with a greater number of lamps and reflectors than the lights of relative importance in this country, and the distinction between sea-coast and harbor lights is made in Ireland. (See tables of English, Scotch and Irish lights, with the different numbers of lamps, and compare them with the table of the United States lights.)

The lights of the United States *have not the benefit of the best illuminating apparatus of the kind, in general use; they are not inspected regularly at short intervals of time, and do not receive the same care and attention, which is bestowed on the European and the colonial lights; hence the mere estimate of relative annual expense can afford no just idea of their comparative, useful and economical effect.*

In Europe, the ablest engineers and scientific men are employed on the subjects of construction, illumination, ventilation, and other highly important investigations, connected with a properly organized light-house establishment, who are paid for their services from the funds of the establishment.

In this country, no such system obtains; for, whenever an officer of ability is to be charged with light-house duties, he is detailed from the army or navy, for that service, and his pay comes from the appropriations of those departments; thus saving to the light-house account large sums annually, which would otherwise be placed against it.

It is also known that, notwithstanding the large amounts annually appropriated for repairs and renovations, yet, there are many towers and buildings, and much illuminating apparatus, &c., &c., requiring large outlays for necessary repairs.

The average annual cost of maintenance of the light-vessels of the United States, and the illuminating apparatus employed in them, for the last six years, is \$2,891 24. "The illuminating apparatus used in our light-vessels is the compass-lamp." "No Argand burners and lamps are used." "It is simply a reservoir to hold the oil, with a number of wicks placed around the circumference;" (solid cord-wicks, the flames being fed only by the exterior current of air.) (See letter of Fifth Auditor to light-house board.)

"The light-vessels in England are fitted with Argand lamps and burners, and parabolic reflectors, for both fixed and revolving lights." (See Senate Doc. No. 488, page 16, first session twenty-ninth Congress. See, also, Trinity House returns to Parliament.)

In 1849, seven (nearly one-third) of the Trinity House floating lights were fitted with revolving reflector apparatus.

Of the forty United States light-vessels, on the corrected list furnished to the light-house board, twenty-eight are placed in sounds, bays, and rivers,

in positions of comparatively little exposure. They vary in size from 54 tons to 180 tons; average 103 tons each.

There are two condemned iron revenue cutters, 400 tons each, in positions which are not much exposed.

The ten remaining light-vessels are in more exposed positions; varying in size from 129 tons to 230 tons, and averaging 171 tons each. The Sandy Hook light-vessel, of 230 tons, is in a position of as great exposure as any on the coast, and is the largest of all the light-vessels proper.

The Sandy Hook light-vessel and the Stratford Point light-vessel cost, for maintenance, in 1850, (see returns,)-----\$11,527 14

The Stratford Point vessel being 100 tons, (under the average size,) it may be assumed that the average will be a fair amount for maintenance ----- 2,891 24

Thus leaving for the annual cost for maintenance of the Sandy Hook light-vessel ----- 8,635 90

Although this light-vessel is in an exposed position, there are many in the English and Irish channels, and off the coast of Great Britain, in much more dangerous ones, and more difficult to be kept at: still they seldom break adrift. The English light-vessels are larger, and, in every respect, greatly superior to those in the United States. The illuminating apparatus and moorings, (to insure certainty of position,) are of the best quality. Large crews, under the command of able seamen and mates, have charge of these vessels, and few casualties occur. Spare vessels are always ready and kept near at hand; and, in consequence of the superiority of the illuminating apparatus, they are seen nearly as far as shore-lights of the same elevations.

Fog signals, consisting of gongs, blue-lights, &c., &c., are supplied to these vessels, as well as all that is necessary for aiding the shipwrecked. The following average for the maintenance of English light-vessels includes all repairs, renewing old ones, &c., &c. In the United States special appropriations are made, whenever new vessels are required to replace old ones; but these do not appear in the average of the annual cost of the United States light-vessels:

The average cost of light-vessels of the Trinity House, for

1844, was, for each one - - - - - \$6,100 00

1845, " " - - - - - 4,850 00

1847, " " - - - - - 6,400 00

1848, " " - - - - - 7,900 00

No returns for 1849-50 and '51.

4) 25,250 00

Annual average for four years - - - - - 6,312 50

Average for the United States light-vessels—*inferior in every respect to the English*—\$2,891 24.

Take the Sandy Hook light-vessel (being the largest and in an exposed position,) for comparison, though not larger, nor in a more exposed position than nearly all of the English vessels: \$8,635 90; giving a difference in

Ex.—4

favor of the English light-vessels, on the score of annual expense, of \$2,323 40.

The quantity of oil consumed in the "compass lamp" is very small, compared to that consumed in Argand lamps; and some of the English light-vessels have as many as 24 lamps and reflectors; the useful effect being on an average in the proportion of 1 to 4: that is—in illumination alone—the English light-vessels are four-times as useful as the United States floating-lights.

The average cost per light-house of the American lights, and those of Great Britain, for the different years, with the number of lamps and reflectors on an average in each, also exhibits the comparative economy of the lights in the two countries.

1850, United States lights—averaging $9\frac{8}{10}$ lamps each; cost on an average-----	\$1,218 74
1843, Trinity House lights—sea-coast; averaging 13 lamps each-----	1,840 50
1843, Scotch lights—sea-coast; averaging $17\frac{1}{2}$ lamps each---	2,322 00
1844, Irish lights—averaging 20 lamps each-----	2,043 00
1844, Irish harbor-lights—averaging $7\frac{1}{2}$ lamps each-----	877 50
English colonial lights—averaging about-----	1,150 00

The American lights have but one keeper, except, in about a dozen instances, a single assistant is allowed. In the English, Scotch and Irish lights, all sea-coast lights have not less than two keepers, and many of them, from their very exposed positions, have three and four keepers each.

No comparison can be made of the French and American lights, from the fact that there is not a single first-class light on the American coast, and there are no reflector lights of any note remaining in France.

A reference to the returns of expenses for maintenance of British colonial lights and light-vessels, will show favorably in comparison with ours.

The average annual cost of keeping up the Irish floating lights was, in 1846-----	\$2,700 00
Do. do. do. in 1848, about-----	2,500 00
Or an average of about-----	2,600 00

The Irish light-vessels are generally smaller, and placed in less exposed positions, than those of the Trinity House; though in some instances they are in equally, if not more, exposed positions than those of England, and in much more exposed positions than the majority of those in this country.

There is but one floating-light in France, fitted with the best dioptric apparatus, but kept up at a very small expense per annum.

The Scotch have no floating lights.

The average of the annual appropriations for buoys, beacons, lights, &c., in this country, is-----	\$813,668 60
For purchasing supplies, delivering them, and making one visit of inspection annually, in 1851-----	152,081 59

Transportation of supplies-----	\$11,437 00
Inspections once a year-----	3,200 00
Commissions on purchases-----	12,908 92

27,545 92

For this sum the most rigid system of inspection, superintendence, instruction and accountability might be introduced, and a more expeditious mode of delivering supplies at short and stated periods introduced; and hence a strict accountability on the part of those employed in the service. The repairs of the illuminating apparatus, involving an annual expense of \$12,183, would then be made by mechanics of known skill, under the supervision of a competent engineer.

The large sums expended annually for repairs, show clearly that the buildings were either badly constructed at first, or that the repairs are not made by competent persons, and under the inspection of competent engineers. The towers and dwellings of the lights visited, attest the truth of the great want of *true economy in this branch of the light-house establishment*. Light-keepers' supplies are not accounted for as rigidly as a proper system would require. The returns of the expenditures of oil, wicks, chimneys, &c., &c., are too partial, or in too general terms, to admit of proper scrutiny. No rule or system is followed in delivering supplies to light-keepers. The person charged with that duty delivers such articles, and in such quantities, as he thinks proper, and requires the keepers to receipt to him for them. The quality of the articles is frequently inferior to the requirements of the service, especially in the articles of polishing-powders, trimming-scissors, glass chimneys, wicks, &c., and in many instances, of oil.

There are no inducements held out to keepers to use proper economy in the management of their lights, and no checks upon them.

In procuring light-house supplies of all kinds, too little regard seems to be had as to quality of the articles, and too much latitude given to those who may be interested in the purchases. Articles are procured and left with the keepers, which are of inferior quality; extra lamps and burners, reflectors, &c., are often left at light-houses where no good reason could be discovered for having so large a number of spare articles at one point. At Reedy Island light-house, (a gas-light,) a complete set of new lamps and reflectors was found, in addition to a set of lamps and reflectors kept ready to be put up, in the event of having difficulty with the gas-light.

There is no regular list of articles required for the different light-houses; no indications to guide the keepers, by which they are to judge of the quality of the supplies.

Delays, consequent upon the mode of delivering supplies only once a year, in making repairs, have proved detrimental to the public service.

The absence of a proper inspection and superintendence of the repairs of towers and buildings, has been apparent in nearly every instance which has come under the observation of the board. The mode by which contractors for repairs, and for new structures, obtain certificates of having performed faithfully the work contracted for, is reprehensible, and should not be permitted in future. *There can be no true economy where the contractors are not held to a strict accountability, and the work intrusted to them not executed under the immediate supervision of a responsible and competent engineer.* The present defective mode of construction and repairs of towers and dwellings may be remedied by carrying out the ninth section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851:

“Sec. 9. *And be it further enacted*, That the President be, and he is hereby required to cause to be detailed from the engineer corps of the army, from time to time, such officers as may be necessary to superintend the construction and renovating of light-houses.”

RELATIVE ECONOMY OF UNITED STATES AND FOREIGN LIGHTS—CONTINUED.

The fifteen lamps and twenty-one-inch reflectors placed in the Cape Cod light-house in 1840, cost each, complete-----	\$111 90 .
The eighteen lamps and twenty-one-inch reflectors placed in the Cape Henlopen light-house in 1840, cost each, as estimated with other repairs made by the same contractor-----	88 90
The fourteen lamps and twenty-one-inch reflectors, made in London and placed in the Boston light-house, cost each-----	131 50

In the case of the Cape Henlopen light, other work was executed by the contractor who furnished the lamps and reflectors, amounting to \$2,000 additional, while the contractors for the lamps and reflectors for the Cape Cod and Boston lights only furnished the lamps and reflectors, precluding the possibility of placing the lamps and reflectors furnished by them at any other than a fair compensation for their materials and labor. The contractor, on the contrary, *had a large margin* for making up his deficiencies in that branch of the work, at Cape Henlopen.

Taking, then, these three lights, the comparison of relative merits and cost will appear as follows:

The Boston reflectors and lamps, made in the best manner, form, shape, and finish, cost-----	\$131 50
Six ounces silver to the pound of copper used in their construction, making, in actual silver, between \$50 and \$60 each—say----	55 00
Leaving for other materials and labor-----	<u>76 50</u>

The Cape Cod reflectors and lamps, made in Boston, cost each--	\$111 90
Fifteen ounces silver to each reflector-----	15 00
Leaving for other materials and labor-----	<u>96 90</u>

The eighteen lamps and twenty-one-inch reflectors put up at the Cape Henlopen light, by a different contractor from the one employed to make the Cape Cod lamps and reflectors, cost each, on the general estimate for the repairs-----	\$88 90
Fifteen ounces silver-plating-----	15 00
Leaving for labor and other materials-----	<u>73 90</u>

The present condition of the reflectors now in Boston light, made in London, and put up in 1839, compared to those put up in the Cape Henlopen light in 1840, is sufficient evidence of the fact that the Boston reflectors, although costing the most, *are, in true economy, the cheapest*. In the Henlopen light the silver is worn off the reflectors in many places, while the Boston light reflectors are still good.

Deducting the difference in silver actually used for the plating, and the cost of the Boston reflectors is only \$2 60 more than those put up at Cape Henlopen about the same time, and now nearly worn out. The difference,

compared with the Cape Cod reflectors, is in favor of the Boston light, (assuming that the quantity of silver for plating is correct, that being the quantity contracted for by the general superintendent of lights, &c., for all reflectors of that size.) As this light was not visited by the board, the condition of the reflectors is not known.

The following are the prices paid for reflectors of twenty-one and a half inches, fitted with brass vase lamps, complete :

At Birmingham, England, Soho Company.

For 21½-inch reflectors and lamps, with six ounces of pure silver to the pound of copper-----	\$142 00
For the same, with four ounces of pure silver to the pound of copper-----	113 25
For the same, with two and a half ounces of pure silver to the pound of copper-----	93 25

In London.

For strong, silver-plated, highly-polished parabolic reflectors, twenty-one inches diameter, with improved patent lamp-----	122 00
The same, with inferior plating-----	109 00

The present contract price for twenty-one-inch reflectors, having fifteen ounces only of silver on each of them, without lamp, burners, or fixtures, is, in this country, sixty dollars. In addition to this, the same contractor supplies various articles, by which he may easily reimburse himself, should there be any loss on the few reflectors annually required for the lights, compared to the amount paid for stores; besides, the quality, shape, and finish of those most recently made, seen by the board, are greatly inferior to what they should have been. (Vide Notes of Inspection, appendix A.)

Parabolic reflectors, well made, with such a thickness of silver plate as is required, and only employed in the few remaining reflector lights of Scotland, if properly cared for, and no improper cleaning-materials are used, will last, probably, upwards of twenty years, while those of an inferior quality require to be renewed in from ten to twelve years, if good lights are kept.

That these articles can be as well made in this as in any other country, no one can doubt; *but it is necessary that our skilful mechanics should have a fair remuneration for their materials and labor, to insure the best articles.* If an unprofitable contract is made by the government with an individual, it is neither just nor reasonable to suppose that the government is to gain at the expense of the mechanic's labor. By the introduction of a wholesome system of inspection and superintendence in these important matters, it would soon be ascertained for what amount the different qualities of apparatus could be manufactured, rendering justice to all parties. The government would then be certain of having the best articles; and the manufacturer, of a fair remuneration for his labor and materials. There is no true economy in a system of extravagant annual repairs, and a constant renewal of apparatus.

The fabrication of parabolic reflectors for light-houses requires ability, care, and great labor. The form is a most essential element; the finest polish, &c., another; and the quality of the plate equally important. Re-

flectors, such as have been seen by the board, might be made at almost any price, above the actual cost of the materials used. A pretty fair estimate of the quantity of silver employed on reflectors of 21 inches diameter may be formed.

They weigh usually from nine to eleven pounds when finished, of which quantity, of the best construction, every pound of copper gives 6 ounces of silver; and so on, to the most inferior quality.

It has been seen elsewhere in this report, that the Trinity lights

cost per lamp, per annum-----	\$142 88
The Scotch-----	133 50
The Irish seacoast-----	102 00
The United States, average for six years-----	119 55

It must be remembered, also, that as a general rule, (and there are only about 14 exceptions,) there is but one keeper to the lights in the United States, while no seacoast or important light in England, Scotland, or Ireland, is not furnished with at least two keepers, who receive on an average, including fuel, rations, &c., larger salaries than the keepers in this country.

In Great Britain, inch-burners, and in this country $\frac{3}{4}$ -inch burners, are used, making considerable difference in expense of oil, as well as in the power of the light.

The colonial lights of Great Britain, with two or more keepers, cost much less per lamp and per light-house, per annum, than those of Great Britain or the United States. (Vide returns of colonial lights, appendix.)

The large repairs, and frequent renewal of the apparatus in the United States, *would alone suffice to render the establishment one of less real economy than those of France, England, Scotland, and Ireland.*

These lights abroad have no custom-house or other officers to superintend them free of charge, as in this country.

It has been found in Great Britian, that the expense of fitting

up a revolving light with 24 reflectors, is-----	\$5,763 13
And the fitting up one with lenses, with all the accessory parts	
and improvements, is-----	6,477 96

By calculating the difference in cost of annual maintenance, and allowing for interest on the first cost of the two systems, it will be seen that there will be an annual saving of \$283 72 by the lens apparatus, and at the same time a better light; an apparatus, too, that will never require to be renewed.

The first cost of the smaller lights in the two systems may be put down as follows, assuming that the lanterns and every thing relating to the buildings will be equal in both systems:

First cost of a fixed sixth order lens with 3 lamps complete---	\$216 00
First cost of small harbor or beacon light, for lamps and reflectors only, (see present contract, appendix)-----	297 50
First cost of a fifth order lens with 3 lamps complete-----	354 00
First cost of a reflector light equivalent to it, from \$297 50 to \$387—mean-----	342 25
First cost of a fourth order lens with 3 lamps complete, with chandelier and accessory pieces-----	661 00
First cost of a fixed reflector light, as nearly equal to the fourth order lens as possible, is not less than \$459 to \$567—mean	513 04
First cost of a third order lens light with 3 lamps-----	1,860 00

First cost of reflectors and lamps to make a light as nearly equal to it as possible—for example, Cape Henlopen, the actual cost of which we have already seen—and after 11 years' service requires to be renewed, while the lens will last forever ----- \$1,600 00

For the relative annual expense of maintenance of the lights, and for the comparative brilliancy and useful effect of the Brandywine shoal, a third order lens light, and that of Cape Henlopen, see remarks in another part of this report, and also the notes of inspection in appendix A.

For fitting up Boston light-house with 14 twenty-one inch reflectors----- \$4,749 16

For fitting up Cape Cod light-house with 15 twenty-one inch reflectors----- 5,919 40

For fitting up Thatcher's island light-house, 2 lights, 20 twenty-one inch reflectors----- 5,360 00

For Cape Henlopen, new lantern, and 18 twenty-one inch reflectors----- 3,500 00

For Cape Henry, as above----- 4,000 00

Compare these sums with the cost, as estimated above, for a revolving light with 24 large parabolic reflectors, costing nearly double the estimated cost of those used in this country, and it will be seen that the difference will be in favor of the foreign light; that is, increase the number of reflectors in the Boston light to 24, and instead of \$4,749 16, add the cost of the ten additional ones, and the whole cost will be \$6,064 16. In the cases of Cape Cod and Thatcher's island, the difference will be much greater in favor of the foreign economy.

There are at present forty-two floating lights authorized by law, and two more (one for the South shoal off Nantucket, and another off Cape Fear, Frying-pan shoals) are required. To render these forty-four light-vessels *useful and economical, it is indispensable that they should be fitted with Argand lamps and parabolic reflectors*, requiring about five hundred and forty in all. To accomplish that purpose without much expense to the country, it will only be necessary to take from the thirty-eight seacoast lights proposed to be converted into first order lens lights, with as little delay as possible, all their reflectors and lamps, and placing the best of them in the most important light-boats, which will produce a net saving of many thousands of dollars; while the country is only doing what it is bound to do, in saving human life and property from destruction.

These thirty-eight reflector lights contain about 540 lamps and reflectors, the number required to fit up all the light-boats.

They would cost, if purchased, from \$35,000 to \$45,000, and would be equivalent to that sum gained in the purchase of the necessary lenses for the seacoast lights.

The *absolute necessity* for fitting up the light-vessels with proper apparatus, has already been clearly shown. The necessity for better seacoast lights has also been seen. The great saving in expense by the introduction of the lens system is clearly demonstrated, both by theory and practice. It is important to remember, that in many of the light-houses the introduction of the lens apparatus will be attended with no other expense than the actual cost of the lens and that of putting it on its pedestal. All the lanterns

fitted with plate-glass, and in tolerably good condition, will answer as well for the lens as the reflector apparatus, and in many instances better. The reflectors, as a general rule, take up much more room than the lens apparatus. If repairs are required at all, they will be required with either kind of illuminating apparatus.

The great defect to be remedied is one that exists independently of both systems: that of *want of sufficient elevation*. (Vide appendix, showing heights of the principal seacoast lights in this and foreign countries.) Time, and a gradually progressive improvement in this important branch of public service, *must remedy this glaring defect*. The introduction of other apparatus will not militate against such gradual improvements. From the perfect character of the lens, it can be taken down and put up without fear of injuring its efficiency.

DESCRIPTIVE LIST OF LIGHT-HOUSES, BEACONS, BUOYS, AND SEA-MARKS.

The board have endeavored to obtain from the general superintendent of lights, &c., the data for such a descriptive list; but the materials are not probably in the office for its composition. The list transmitted to them of beacons and buoys, was obviously too imperfect to answer the purposes intended by the department. They have, therefore, taken steps to procure from the local superintendents the necessary information, with which they have commenced compiling such a list as the instructions prescribe, of all the light-houses, beacons, buoys, &c., which, when completed, will be presented in a future report to the department.

The list of light-houses and light-vessels, printed by authority of the general superintendent of lights, &c., in 1851, is deficient in many essential points of descriptive detail, is not sufficiently widely circulated among seamen and others interested in commerce and navigation, and is in some instances incorrect. The president of the board called the attention of the general superintendent to this latter point.

The lights along the coast should be placed on the list *in the order of their positions on the coast, commencing at one boundary or the other, having regard especially to their latitudes and longitudes*.

The names of the seacoast and other first-class lights should be printed in *capital letters*, as a signification of their character.

The names of the first-class lights should correspond, as nearly as possible, with the most prominent point of coast near which it is placed. Names of small islands, inlets, &c., which are scarcely known beyond their neighborhood, should never be used to designate a seacoast light. Numerous instances of this kind might be pointed out, as existing on the present light-house list.

In compiling a proper descriptive list of the lights, especially with reference to those of the first class, and most important to the over-sea voyager, the chart of the coast should be the guide: commencing, for example, at our northeastern boundary, take the entire coast line to the Rio Grande.

The secondary (bay, harbor and river) lights might be placed in the order in which they are placed in ascending from sea. Take as an example, the Delaware bay, &c. Coming from the east, "*Cape May revolving light*," &c., would appear in capitals; next to it would be placed "*Cape Henlopen fixed light*," in capitals. Then should follow, in smaller type, all the light-houses and light-boats, in their regular order, alternating from

side to side of the bay, as far as they reach. The same rule should be observed with all other bays, harbors, &c.

Montauk, Fire Island inlet, and Highlands of Navesink should appear in the same order, and printed in capitals; then should follow Sandy Hook, East Beacon, West Beacon, &c., &c., in smaller type; but each light, whether *large or small*, should be minutely described, so that the stranger can never be at a loss to know where he is, on first seeing the artificial means provided by the government for that purpose. Lights supplied with fog-signals should be stated in the remarks. Views of the coast, embracing all the natural and artificial objects calculated to aid the navigator, are placed on all the coast survey charts; but these aids are omitted on those now generally in use by navigators. It therefore becomes the duty of the officer charged with the management of the lights, &c., to see that no item of description should be omitted in the lists of lights, buoys, beacons, &c.

Correct and carefully made descriptive lists of beacons, buoys, and sea-marks, embracing bearings, objects intended to be subserved, &c., &c., of every bay, river, and harbor, should have a place in the general light-house list, to which notes, explanatory remarks, &c., should be added, relating to removal, replacing, &c., &c.

The department has further required of the board, in accordance with the phraseology of the law, a

DETAILED PROGRAMME TO GUIDE LEGISLATION IN EXTENDING AND IMPROVING THE PRESENT MODE OF CONSTRUCTION.

On this subject, the board submit from their committee, composed of the two engineer officers serving as members, the following report:

The number of light-houses has increased under our present form of government, from about eight seacoast lights given to us by the war of the Revolution, to 315 of all classes, according to the official reports for the year 1851; but these do not include all that have been built by the United States. In the year 1791, were built the first light-house towers. Thenceforth the number of these establishments continued to increase, until at the close of 1819 there were 64 within our limits; so that in the course of twenty-nine years, there were 56 erected. In the succeeding twenty-three years, or from 1820 to 1842, (inclusive) there were erected some 200, and from 1842 to 1850, (8 years) 57 more, or in all 315. But from these numbers we are not to infer that, up to the period stated, there were no more constructed, for, on the contrary, a number of those on the official lists have been rebuilt or refitted, at considerable cost, (we refer especially to the official report for 1842 and the official list for 1848.) It is worthy of notice that this source of expense is not found to be uniformly distributed, either geographically or with reference to the age of the buildings. We find that the greater number of reconstructions have been confined to a very few States, remote from each other in geographical position, and that they have been found necessary in the case of new as well as of old structures. For example: thirteen light-houses had been rebuilt in Massachusetts alone, to the year 1848, and in the State of Maine, eight. In some of the States it has not been found necessary to rebuild any, even of those of considerable age, whilst in Florida, where all that have been replaced were comparatively new, there have been seven out of fifteen rebuilt, at a cost of nearly \$74,000. These numbers (namely, the number of those rebuilt) are

strikingly great in proportion to the whole of the list of existing works ; and they are still more worthy of attention, if we add to them the number that have been refitted wholly or partially, or about seventy. Again, it should be remembered that four-fifths of the light-houses we are referring to, have been erected since the year 1819—namely, those reported to the 1st July, 1842 ; for that report, as already said, gives 264 as the total number of light-houses, 200 of them having been built or rebuilt since 1819, or during the 23 years immediately preceding, and only 64 of them being over 23 years old. We have not the precise elements for calculating the per-centage on the first cost of construction, but the materials at command would indicate as probable four or five per cent. as the annual charge for repairs.

Very generally, these structures are anything *but creditable to the reputation of those who have had the charge of erecting them*. So far as our own observation extends, and in many other cases, according to very credible testimony, they are inferior, as well in the materials as in the workmanship ; often, very remarkably so. This same judgment has also been given by others heretofore, and it has been controverted. But we conceive that the official reports and statements furnish of themselves very strong evidence of its soundness ; we would therefore call particular attention to those estimates, and especially *to the very large sums annually asked for under the caption of "repairs, &c., of light-houses."* We are not instructed as to the items intended by the very general clause we find in this heading, but we may reasonably presume that it has reference only to such expenditures as connect themselves with the renovation or preservation of these structures, because any other assumption would be adverse to the idea of an intelligent classification of the items of expenditure. The official estimate for the fiscal year 1850-'51 (the last) for repairs, &c., of light-houses, is nearly \$86,000, at the rate of probably four or five per cent. per annum on the original outlay, *in order to maintain them even in the state of dilapidation in which several of them are now to be found*. We give the aggregate cost of repairs for that year on all the light-houses, old and new, well and badly built, and the comparatively new comprehend a very large portion of the whole. If we were to pursue the investigation in this report as far as we have in the documents, it would be seen how small the general average of four or five per cent. per annum would be, compared with particular cases, and how very costly, in fact, are the works of inferior construction. But to the expenditure for repairs should be added that for the reconstruction of such as have been decayed, or destroyed, otherwise than by an enemy. This addition would very seriously increase the sum now included under the head of repairs ; and it might further be enhanced, by adding the expenditure for refitting, more or less extensively, some seventy light-houses.

We may infer from what has been said, that it is not always economical to build low-priced light-houses ; for if even they were to require an expenditure of only four per cent. per annum on the original cost of construction, in order to maintain them in a doubtful state of repair, we would have expended upon them as much money as would, at the end of twenty-five years, enable us to erect structures of great strength and durability in their stead, or such as would be beyond the hazard of the elements. Nor is this statement based upon extreme or on a few cases. We have, it is true, light-houses which have stood more than twenty-five years, and still require but

little repair. These, however, are the exceptions to the rule. We have the case of many others that have not stood more than one-fifth of that time, and some that have not stood even so long as that. But the economical difference in favor of a well and substantially built light-house is this, namely: that with the one there is an unlimited security with respect to time, and without further cost than the original outlay; whilst with the other there is an ever-increasing expense, and an ever-increasing insecurity.

With the exception of works designed to resist the fire of heavy batteries, there are, perhaps, among the higher class of structures, none that require so careful a selection of materials, nor greater professional knowledge, care, and skill in their preparation and combination, than is required in the building of works exposed to the shock of the sea, or even in those which, near the ocean, receive only the slow attacks of time and of the weather; and most especially is this true of *light-houses* built in such situations. Their small bases, great height, and naked exposure, subject them, in an eminent degree, to the influence of the causes which operate everywhere to the destruction of artificial works, and especially where they are exposed to the waves, to the spray, or even to the sea atmosphere.

Nevertheless, it has been, in general, the practice of this government to abandon these works to the chance management of whosoever might undertake them for the lowest sum; and to them are intrusted, very generally, the construction of our light-houses, and in the absence, too, of any efficient system of inspection. And this is not the fault of to-day only; it has been the practice ever since the enactment of the organic law of the light-house establishment in 1789. Under such a system we cannot be surprised to find these structures badly built, and costing such large sums for the repairing, refitting, and rebuilding of them. Our light-house establishment seems to be the sole exception to our practice of building for the future as well as for the present. In it there seems to be ever a lurking apprehension that our naval and commercial existence is but *temporary*. But it seems to us that the nation owes so much of its prosperity and power, and so much of the renown it has acquired, to our marine, military and commercial, that its safety, whilst afloat, should be carefully provided for, and with a liberal hand. Very large sums of money are yearly expended by the government in erecting not only solid but richly decorated structures for the storage of the cargoes of our merchant ships, and for the collection of the revenues arising from them; similar examples of liberality manifest the disposition of the government with respect to all the other great works it has undertaken, and especially we may exemplify this liberality in the case of the public buildings at the seat of government; in the fortresses of the country; in its arsenals, and in its great naval establishments; all of which are of the first character for the excellence of their workmanship and materials, and for the ability with which they have been designed, and the fidelity of their execution. So that we may reasonably hope that liberality may be extended hereafter to the light-house system, upon the perfection of which so much depends the security of our navigating interests; and the more so, since the nation has attained to a character for permanency which may well warrant the expenditure of money for the purposes of the future, and because, in so doing, we will be countenanced by the practice of the wisest and most successful of the maritime powers of the world.

It is evident from what has been already said, that we suppose that light-

houses ought to be made as durable as the circumstances of each case will permit, and as secure from casualties; and hence, that the introduction of materials easy of ignition ought to be carefully avoided, as well as those that are liable to rapid decay; and that, therefore, carpentry should generally be excluded from the interior and exterior of such works, if they are of any degree of importance, or intended to be permanent. The same objections apply to the use of wood-work of nearly all kinds (joiner's work) for which there might be substituted in many cases some one or other of the metals. These opinions are founded on the conviction that the introduction of this material to any serious extent into the body of a lighthouse, is very objectionable because of its known liability to decay, especially in a humid atmosphere. But the danger of conflagration is the main objection to the extensive use of timber in the construction of light-houses, because even the utmost care cannot always guard against its occurrence. But there are seasons in which the sudden destruction of one of these establishments might lead to shipwreck. In employing extensively, therefore, any inflammable material in them, we would be but sporting with life and property. These remarks are predicated upon the supposition that the works they refer to are in exposed situations, and that they are, at all times, really necessary to the safety of navigation.

Iron has been employed for some years past as a material for light-houses. It is used both as castings and wrought. There are peculiar situations in which it is preferable to any other. Among the forms in which it has attracted most attention in the United States, is that which connects itself with screw foundations. Those situations most favorable for the employment of these sort of structures are those which are exposed to the action of the waves, where a sandy or even gravelly bottom might be liable to be disturbed by the currents which solid structures under water are so apt to generate, and where any such disturbance might lead to the destruction or injury of neighboring navigable channels. In these cases the impediment presented by a few slender iron piles would be so slight, that they could have no injurious influence upon any of the currents in the vicinity. There are also other localities where the erection of a more solid structure might involve the expenditure of sums of money greatly beyond the value of the structure to commerce, as there may be also others where the solid surface to be built upon may not be adapted to receive any other kind of structure than that composed of iron piles.

These iron light-houses have not as yet received all the improvements of which they are manifestly susceptible; nor have they, in the public mind, received all the sanctions of experience with reference to their sufficiency or safety. On the contrary, some serious mischances have characterized their history, and have not a little tended to prejudice the public against them, and especially the minds of those who are without the means of investigating the cases of failure which have occurred.

It has been made the duty of our committee to investigate the mechanical principles involved in this sort of structures; the sufficiency of the materials of which they are composed, and their adaptation to the purposes for which designed; and in the performance of this duty, it has had occasion to investigate the causes of the very few failures which have occurred, both here and in Europe. It is very reasonable to anticipate that in the first cases of the employment of so novel a system of building as is this of the iron pile light-house, precautions may be omitted, and that errors may

occur, in planning or executing them, which a more extended experience may correct. We are not, therefore, disposed in such a case hastily to attribute or to censure faults, if any should be committed, in the first experiments. We prefer to profit by the experience of those whose enterprising intelligence and whose opportunities have enabled them to instruct us in regard to them. Since the introduction of the iron pile light-house into the United States, the system has very largely occupied the attention of the Bureau of Topographical Engineers, and several of them have been planned and executed under its direction. In almost all of them, and especially in those more recently designed, we find most striking improvements upon the models which have come to us from England, where they were first employed; improvements which affect materially their strength, stiffness, and safety, as well as their capacity for the accommodation of those who are employed to take care of them. It has been made also the duty of your committee to plan a work of a similar character for the entrance of the Patapsco river; and into this we have introduced still further improvements, which seem to be of essential advantage in such structures, and which serve to obviate some objections which applied to other similar works.

Other forms of iron light-houses have been proposed, and some have been executed of cast iron. These are designed, generally, for situations out of the reach of the waves, and for situations so remote from more suitable materials of a durable character, that the cost of transportation, added to unusually high prices of labor and workmanship, occur as serious objections to the employment of such materials. Some parts of the coast of California may be instanced as suitable for this latter kind of structures.

There are several objections urged against the use of iron as a principal material for light-house towers; one of which, and an important one, is the liability to oxidize, and especially such portions of it as may be much exposed to unfavorable atmospheric and hygrometrical influences. It is objected, also, that in salt-water, cast iron may ultimately be converted into a substance resembling plumbago, and its strength materially injured. The best structures of masonry, if they have a solid foundation, form nearly unyielding masses, scarcely feeling the shock of the waves or the winds. An iron light-house, on the contrary, owing to the great number and comparative looseness of its parts, always vibrates under the influence of these forces. There is, therefore, much friction in it, and this tends necessarily to wear it at all the joints, so that however strong or stiff it may be at first, it must ultimately yield, more or less, to such influences. Moreover, iron castings are liable to flaws, which are not easily detected before they are brought into use. These objections, although not fatal, are undoubtedly deserving of, and have received, consideration. Means have been proposed by which the process of oxidation may be delayed. The quantity of metal in works of equal general dimensions has been recommended to be increased to a degree varying with the exposure of the structure, and, by our committee, effective means have been devised for renewing or repairing at all times, any part, whatever, of the structure that may be found to require it, and this without materially disturbing the structure.

Moreover, under the instructions of the Topographical Bureau, the officers and agents employed upon such works have effected very important improvements in the arrangements requisite for increasing at any moment the stiffness of iron-pile towers, and it has given to them greatly increased accommodations beyond those that had been used by the English engineers,

to whom we are indebted for the general principles upon which such works are based. With these improvements and precautions, combined with a prudent increase in the dimensions of the details, varying with the peculiarities of each case, and the security of an ample base for them, we have no hesitation in recommending their use at all the points at which the peculiarities of the locality may render it imprudent to erect works having solid foundations, or where the difference of the cost of these and the usual light-house towers may be such as to be of sufficient pecuniary account. We may mention, as a further important advantage of these iron structures, that they may be, as they always have been, in the United States, put up at the foundry or shops at which they are made, and fully inspected and perfected before they are accepted, and before leaving the yard of the establishment, so that they may be transported to any point, however remote, under the conviction that on their arrival at their ultimate destination, they will, in all their principal details, conform to the plans of those who design them, and will require at such point little more than the expenditure of the sums necessary for their bare erection.

Iron, (cast, wrought. or rolled,) plain, corrugated, or ornamental, may also be often very usefully and economically employed in light-houses, for stairs, galleries, railings, doors, shutters, door and window frames, and for joists, flooring, partitions, &c.

But the materials most extensively used in light-house towers of the best construction, or those from which we are to expect the greatest strength and durability, are brick and stone. In certain situations, and under certain circumstances, bricks may be very advantageously employed as a material for light-houses, especially where the difference of cost of brick and of stone, of a suitable quality and form, is of importance, sufficient to warrant its preference, and the quality of the material itself is such as to satisfy us of its strength and durability. Under favorable circumstances, and where an unusual power of resistance is not requisite for the stability of the work, the use of brick may be recommended even extensively; and in so doing, we have the experience of some of the most ancient structures extant, which still remain to attest the durability of brick, when employed in situations favorable to it. The most durable specimens of brick-work known to us are those of burnt bricks which have descended to us from the Romans. With us, the clay of which the bricks are usually made, consists of silica and alumina, in combination, sometimes, with magnesia, oxide of iron, sulphate of lime, carbonate of lime, and some other ingredients. On the nature of the constituents, the due mixture of these with water; on the perfect tempering of the resulting paste, and on the time, care, and skill bestowed upon the drying and the burning or baking of them, depend their strength and durability. Their color, being derived from the minerals which enter into combination with the silica and alumina, of course may be modified by varying the proportions of the coloring-matter, but not always without affecting their quality. The strongest bricks employed in building on the Atlantic coast of the United States, are of a reddish or reddish-gray color, derived from the oxide of iron which abounds in the soils. Bricks of various other colors and shades are also manufactured in the United States. Our reddish-colored bricks are, however, generally the strongest and most durable, as are those of the same color which have been preserved in the works of Rome. The best quality of bricks may be therefore safely employed in works not requiring great strength.

Bricks are, however, sometimes subject to the phenomenon which the workmen call "saltpetering;" and they are therefore, however sound apparently, not to be employed without due precautions, especially in the vicinity of the sea, or in connexion with mortars, cements, or plasters, into the composition of which crystallizable salts may have entered. But this subject (the saltpetering of masonry) will be more fully noticed hereafter.

Whatever the situation in which we may advantageously employ bricks in constructing light-house towers, we might also use stone, and with yet more advantage in point of strength and solidity, and equally as to durability; the stone being of the proper quality, and of suitable form and dimensions. But there are other situations requiring the erection of solid structures, where stone should be used in the exposed parts, to the exclusion of all other materials; especially in positions exposed to the shock of the sea. These remarks, however, are not intended to exclude the use of the requisite cements, or of concretes or beton.

The quality, form, size, and dimensions of the stone to be used in the work, are of the first importance, as affecting its strength and durability; and, moreover, there are situations where stone of a certain quality might be used as suitable, whilst in other situations the same stone might be found to be wholly objectionable or inadmissible. Some of the lighter kinds of stone, for example, if they are capable of resisting the disintegrating influence of the atmosphere, or of frost, might be used wherever the use of bricks were justifiable. Situations greatly exposed, as, for example, to the force of the sea, require, on the contrary, stone of great specific gravity, close-grained, and hard, and of large dimensions, not liable to splinter, and free from iron or its oxides, or any other matter liable to oxidize, or to disintegrate, when exposed to the influence of the air, the water, or of frost. But, especially, all the stone used in the erection of the more exposed towers ought to be of large dimensions, in order to band well into the work, to be hammered to beds and points, at least; to be laid in horizontal courses, except in the arches, and everywhere to break joint.

The good qualities of building-stone are: a fine and uniform grain, a compact texture, the ability to resist humidity and frost, and the action of fire, and the not being liable to splinter readily. Weight, also, and the ability to resist fracture or abrasion, are among the characteristics of a good building-stone. All these conditions being fulfilled, the preference is to be given to those stones that may be most easily and perfectly dressed to form, and most capable of retaining it.

In some situations, the inability of certain kinds of stone to resist the chemical action of salt-water, or the attack of certain marine insects, may render them unsuitable materials for the masonry. The same may be said of any stone that adhere to mortar or to the cements. The presence, too, of iron, and of its ores, and, under certain conditions, unusual portions of schorl, and felspar, and mica, may be such as require a more than usually critical inspection of the quarries from which they may be derived, and of the stones themselves, preliminary to their introduction into the work, and especially into the exterior.

To ascertain the existence of these qualities in stone to be furnished from untried quarries, time and circumspection are requisite, and an experienced acquaintance with the material proposed for investigation. In the case of a new quarry, the material it is capable of furnishing should be examined, at various points, and even at different seasons of the year, and various

specimens should be subjected, for a sufficient length of time, to the influence of the air, of water, of frost, and, with reference to some kinds of structures, even of fire, as well as to the test of the workman's tools, and to those which are ordinarily applied for determining the strength and the specific gravity of materials. In the case of stone to be taken from quarries already in use, the inspection need be but comparatively superficial and extemporaneous; but that inspection should be applied to all the specimens intended to be introduced into the building, so as to assure the rejection of all that are insufficient, unsuitable, or defective.

The particular kind of rock from which the stone must be obtained cannot be predetermined. It must, in a measure, depend upon the facilities of communicating with the quarries, and the cost at which stone of various, though suitable, qualities can be procured. It should conform, as nearly as possible, to the description to be found in the preceding paragraphs.

Whatever may be the description of masonry, in a structure of any magnitude, the stone employed in it ought to have sufficient beds, or bearings; for which reason they should be broad and long, in certain general proportions to their height. They should be dressed so as to obtain as regular and perfect bases as the character of the masonry requires. The larger stones of the courses should band well into the walls, in rubble as in ashlar work, and, as much as practicable, they should break joint with the stone of the courses immediately above and below them.

The stones should be well levelled and settled into their beds, and in such a manner that the natural bed of the stone will be placed horizontally; the use of spawls, wedges, &c., as underpinning, should be discountenanced, as leading to the splintering of the materials, and to the settlement of the walls.

Grouting should not be permitted; but the stone should be laid in a full bed of lime-mortar, wherever the use of lime is admissible; otherwise, in a mortar made of lime mixed with cement, or of cement alone.

The mortar, of whatever kind, should be employed for the purpose of uniting the material; and if vacant spaces occur among the larger stone, spawls, and other smaller materials, should be freely distributed through the mortar, so as to consume as little as may be of this. The joints should not be large. In rubble-work there can be but little danger of their being too small. In coursed masonry the courses should be well levelled, after the stones composing it shall have been settled into their places.

It would be out of place here, to speak in any but very general terms on the subject of the foundations of this kind of works, especially of those of the more important classes of them. Upon the resistance presented by the foundations must necessarily depend the stability of the structure, the slightest yielding of the one being inevitably transmitted to the other. The measures requisite for the security of the foundations are very various, and their application depend upon the special peculiarities of each case. But the vertical direction of the force exerted by the weight of the structure is common to all, so that in all cases the resistance should be also vertical, but opposite; and for this reason all the surfaces of the material, not in vertical planes, should be horizontal, except on the exterior and interior surfaces of the building, where they must conform to its architectural outline, and except also in the turning of arches. In order to obtain an equal pressure over the whole surface of the foundation, the specific gravity and the strength of the materials of each course ought to be the same for the backing, if any

there be, as well as for the face of the work. But it consists better with the solidity and stability of the work for the courses to be of ashlar throughout, and that the stones should be well bonded into the walls, and that they should break joint; these precautions tending to secure the work against the unequal settlements likely to result from the employment of materials of inferior strength in courses in which materials of greater weight and strength are also introduced. The same precautions respecting the surfaces or foundations on which the structure is to rest should be observed; namely, they should all be horizontal. But there are often other forces to be resisted besides that of the gravity of the mass; namely, the force of the winds and of the waves. These acting at right-angles with the direction of gravity, are to be opposed by the cohesion and weight, and by the consequent friction, of the materials; from which fact, we may infer that among stones of equal hardness and durability, and dimensions, the heaviest are to be preferred. For the purpose of resisting the lateral pressure of the winds and waves, cements of various kinds are employed, even in ashlar work, in order to establish some degree of cohesion among the materials. For the temporary security of the work, especially the lower parts, during the course of its construction, dovetailing, joggles between the courses, wooden trenails, &c., may be used whenever the circumstances of the case indicate the necessity of guarding temporarily or permanently against the action of lateral forces. These precautionary measures, however, should exclude the extensive employment of iron unless it is to be well covered, because of its liability to oxidation.

Mortars and cements enter largely into the composition of light-houses, and their accessories, as well for the foundation as for the superstructure. The important subject of mortars and cements, and of concretes, and beton, would occupy too much space in this paper. It has of late years occupied a large share of the attention of architects and engineers who have made many trials, and have had a very extensive experience, in their composition and use. Some of these have given able works upon them; and we cannot more safely dispose of the subject in this paper, than by referring to those publications, as guides for such as may have occasion to erect structures requiring the employment of these kinds of materials.

The quality of the sand has a considerable influence upon the quality of the mortar, whether made of lime, of lime and cement, or of cement only, into which it enters as a component; sand should be clean and sharp, and perfectly free from all impurities. The questions, however, which relate to the composition and manipulation of mortars and cements, and the proportions in which the ingredients should be combined, would require too much space in this report, and would be out of place; moreover, they are very ably treated in the publications to which we have referred.

The induration of the usual lime-mortars is attributed to the reconversion of the lime from a hydrate to a carbonate, by dessication and recombination with the carbonic acid gas, of the atmosphere whilst this particular cause of induration, owing to a difference in its chemical combination, is unnecessary and does not apply to the case of hydraulic cements. In the case of common lime-mortar, whatever its quality, the process of induration proceeds gradually, and very slowly, if at all, from the exterior surface of the masonry, &c., towards the interior. From these facts we might infer, *a priori*, that the usual lime-mortars could not always harden in very thick walls, however well built, and that therefore they should not be employed in their

construction, because manifestly the presence of atmospheric air is not always possible in the interior of such walls, nor the complete dessication. And, accordingly,

“Some curious facts might be mentioned, not only to show the influence of a large body of masonry in retarding the solidification of the mortar in the interior, but also of the danger of using the rich limes in cases where such masses are necessary. Among them we may mention a fact, cited by General Treussart, who had occasion to demolish, in the year 1822, one of the bastions erected by Vauban, in the citadel of Strasbourg, in the year 1666. In the interior, the lime, after these 156 years, was found to be as soft as though it were the first day on which it had been made. Dr. John mentions that in demolishing a pillar nine feet in diameter, in the church of St. Peter, at Berlin, which had been erected eighty years, the mortar was found to be perfectly soft in the interior. In both cases the lime used had been prepared from pure lime-stone.

“Pure water absorbs or takes up all the non-carbonated parts of the hydrates of lime. For all purposes, therefore, in which it is required to build in water, or to expose the construction to the action of that fluid, it is necessary to employ such limes only as absorb the carbonic-acid gas instantaneously. Many instances occur in which works executed with the rich lime have failed, from the fact of all the mortar having been carried away; among others, the locks constructed for the improvement of the navigation of La Vilaine, which fell in, from the cause mentioned.”

The water employed in slacking lime, and generally in the making of mortars, ought to be as pure as it can be obtained. Sea-water ought rarely to be used in making mortars, for such a compound may yield, for an indefinite period of time, the saline effervescence which we sometimes find upon the surface of masonry, and generate dampness, external and internal—effects which are objectionable in nearly all situations, but especially in dwellings and in structures where dampness is to be avoided. All mortars, until they have hardened, are deficient in the qualities expected of them as an element of good masonry, and are necessarily exposed to whatever causes of progressive deterioration there may chance to be in their vicinity. Moreover, limes yield less mortar when made with sea-water, and the same may probably be said of other impure waters. In cases where it is difficult to procure pure or fresh water in sufficient quantities, or where the cost of employing it in the fabrication of mortars is an element of too much importance to be overlooked, it will be, of course, necessary to submit to the circumstances of the case, and employ sea-water, as is done in the construction of some of the Scotch light-houses, although the objections to its employment are there well understood.

Our attention is especially directed to this matter, because we find that very different opinions from those we have given, have been entertained at the department charged with the care of the light-house establishment. From House Doc. No. 282, 27th Congress, third session, report of the Fifth Auditor, February 13, 1843, we extract the following:

“TREASURY DEPARTMENT,
“*Fifth Auditor's Office, February 13, 1843.*

“SIR: I have the honor to enclose, for the information of the Committee on Commerce, reports made by the superintendents of light-houses in Maine

and Massachusetts during the last summer, as to the condition of the several light-houses under their superintendence, respectively ; which show—

“That the mortar used in the buildings constructed of split-stone or hard brick was made with fresh-water and sand, in the belief that it was more adhesive than if made of salt-water or sand ; but that experience has proved that the action of salt-water and salt-air upon it, in a short time has decomposed the mortar and rendered it necessary that the joints be re-pointed, which has been done during the last year, with hydraulic cement, in regard to all the light-houses in the State of Maine.

“That it appears from the letter of Eliphalet Grover, esq., who was appointed to oversee the erection of a new tower at Boon’s island, to the superintendent of Maine, (page 15,) that in taking down the old tower, which was built of mortar made partly with fresh and partly with salt-water, it was discovered that the mortar made with the latter was the most firm and adhesive, and therefore more suitable for light-house towers.”

Again, in House document No. 14, thirty-first Congress, second session—report of December 14, 1850—we find :

“Captain Howland in some instances mentions that the mortar with which the towers were built, appeared to be nothing but sand, which crumbled and fell from the joints in buildings erected of brick or stone. He was not aware of the fact, that when these towers were built, it was the prevailing opinion of builders, as well as of this office, that the mortar made of common lime and sand ought to be mixed with fresh water and fresh sand ; and consequently, all contracts prior to 1843 provided that the mortar should be so made. In that year, however, finding on the eastern coast that the mortar in towers built near the sea, in a few years was decomposed, crumbled, and fell from the joints, an inquiry was instituted, when it was found that the muriatic acid in the air, arising from the sea, was the cause of the destruction of the mortar made with fresh water and sand.”

An English engineer of reputation, recently writing upon the subject of limes and cements, refers to the failure of some works at Algiers and Fort Bayard in the isle of Rê, at Brest, and at Cherbourg, in all of which, the ordinary lime had been introduced into the composition of the cements which were applied to the work, immersed in sea-water, and in which he refers to the investigations of Vicat, as follows : “Vicat studied the causes of these failures, and was led by them to some conclusions, which may probably explain not only the disintegration of lime-mortars, but also the destruction of some of the building-stone by sea-water. He found in the sea-water a very considerable portion of the hydrochloride of magnesia, and he proceeded to experiment upon its action upon the hydrates and imperfect carbonates of lime. He found that in a simple solution of the hydrochloride, the particles which were already in a state of perfect carbonization, remained intact ; but that the particles which were simply in the state of hydrates, passed into that of a soluble hydrochloride, and that the magnesia was introduced into the mass, and disseminated throughout the whole tissue. It there quickly passed to a state of a carbonate with the greater facility, when any carbonic acid gas was present. From this, Vicat was led to think that the imperfectly carbonated parts of the cements, whose failure led to the investigation, must have taken up the magnesia from the sea-water, and passed to hydrocarbonates of lime and magnesia, similar to the dolomites, whose formation may, perhaps, be accounted for in like manner. This would, of course, be accompanied by a mode of

crystallization different from that of the ordinary carbonate of lime, leading, doubtlessly, to the disintegration of the whole mass."

The engineer charged with the direction of the works at Rochefort, says: "That besides taking up the magnesia, and passing to the state of a carbonate of lime and magnesia, the mortars at Fort Bayard contained crystals of sulphate of lime. Now as the sea-water does contain a considerable portion of the sulphate of magnesia, it is very probable that the lime may have absorbed the sulphuric acid thus presented, and given rise to the new combination, which, in its turn, must have contributed to destroy the cohesion of the whole body, for the tendency of the sulphate of lime in crystallizing is known to be expansive.

"The practical lesson to be drawn from these researches would be, never to employ the artificial puozzolanos, in the present state of knowledge of this branch of chemistry, for any works of importance where water charged with salts is likely to affect them. It also shows how much care should be taken before employing new compounds in works of importance; for, we see that in these cases no symptom of decay manifested itself during the first three or four years. Such want of precaution is the more culpable * * * * * when we possess natural cements of such undoubted excellence, and where it would be so easy to procure the best hydraulic limes.

"In further prosecuting the subject of the admission of sea-water into the composition of mortars, in the employment of some kinds of bricks or other materials, in which soda or potassa may be present in masonry in damp situations, it is observed that they are often covered with a crystalline substance of a white fleecy appearance, and of a slightly alkaline flavor, which works its way through any ordinary coat of paint; and as it absorbs the humidity of the atmosphere in efflorescing, it renders the walls damp on the surface, and carries off the paint in large patches. This process is called, by workmen, saltpetering, and is in fact the production of a salt from the materials employed in the construction of the walls; * * * * * moreover, its action upon the durability of stone is such that the study of this singular chemical phenomenon, interests the engineer to an equal extent.

"Saltpetre is, properly speaking, a nitrate of potassa; but, although it is regarded as the sole cause of the appearance we now examine, it is far from being the only substance produced in the particular instances, for the nitrate of soda and the chloride of potassium are often to be met with in connexion with the saltpetre itself.

"The nitrification takes place very freely when sea-water and sea-sand have been used, so much as to render them totally unfit for works requiring any perfection of execution. Dumas asserts that there is a very considerable quantity of nitre in the sea-salt; if so, it may explain the injurious action of the sea-water. Brande, it is true, does not mention nitre as being present in the sea-salt; but he states that the earthy muriates are so in the proportions of between 5 and 28 per thousand, the sulphates between 6 and 32½ per thousand. The efflorescence upon works executed with sea-water is, however, very distinctly and decidedly a nitrate of soda; and as it occurs in much greater abundance wherever it is used, notwithstanding Brande's silence, we may safely assume that some portion, at least, of the nitre is furnished by it.

"The practical bearings of this interesting chemical question, upon the professions of the engineer and architect, are as follows:

“ Firstly: sea-water, or sea-sand, should never be used in making up mortar or plaster, which is likely to require painting or any sort of decoration. For outside works the use of sea-sand which has been well washed in fresh water and exposed for at least six months, may be admitted, but it is still likely to cause a nitrification; and as the conditions of temperature internally are more favorable to that action than externally, it is most likely to manifest itself in that direction. There is always a danger attending the use of sea-sand; if it can be replaced, it should therefore be so, even at an increased expense.”

The preceding quotations have been introduced to show the adverse opinions, of authorities in relation to the use of salt-water in mortars; and though the theory of the subject is not yet entirely agreed upon, and there are certainly some diversities of opinion as to the chemical causes of some of the effects mentioned above, there is in these effects a general analogy to experience in our own country. And the “saltpetering” spoken of is not unfrequently seen with us in structures corresponding to those just described. But we have another and even a worse kind, which is due to the presence of soda, or potash, one or both, in the hydraulic cements derived from most of the northern manufactories.

These alkalies in solution, and accompanied perhaps by other salts, being first absorbed from the mortar by porous bricks or stone, afterwards effloresce, throwing off successive scales from the surface of the stone or brick. This difficulty is a serious one in brick work laid in hydraulic mortar, and is another reason for using, with these mortars, only the hardest and least absorbing brick. Very hard and dense bricks, and sound building-stone, are not affected by this efflorescence. The mortars made of our hydraulic limes or cements, with or without common lime, according to the nature of the work, and of the exposure, are excellent, and without other objection than that mentioned. And these limes and cements are so abundant in the United States, and so distributed with reference to the facilities of transportation, and comparatively so cheap, that there can be but little reason for not using one or the other in works of magnitude or importance, for which other limes would be unsuitable or less efficient, whether for the foundation or the superstructure in the body of the work, or for its exterior protection or decoration.

By the term *hydraulic lime*, used above, is meant a lime in which there is naturally a small proportion of constituents which impart the property of hardening, *though slowly*, under water. And by *hydraulic cement* is meant, a compound (containing a very small portion of lime) that, being duly prepared, hardens very *quickly* under water.

In most of the light-houses visited by us, we have found the masonry extremely faulty.

The large number of towers that it has been found necessary to rebuild, and the dilapidated and dangerous condition of others, and the large expenditures required annually for repairs, will bear us out, as we have once before remarked, in this judgment. The objection to the masonry applies to the form, dimensions, quality and preparation of the stone, and the composition and quality of the mortar; the former of which is, in most cases, employed apparently without selection, and without any knowledge or care as to its fitness for the work. The latter material being often at the same time nearly or quite destitute of adhesion, crumbling almost as freely as if it were clear wet.

sand, the stones maintain their position in the wall by reason of their gravity alone, and the resulting friction.

Elsewhere in this report we have spoken of the foundations, and have devoted but very few words to the subject, not because we are not fully impressed with the conviction of its importance, or because we have had but few words to say upon it; on the contrary, the subject is so important and fruitful, and offers so many points deserving attention, that it would be impossible to give even an instructive outline without devoting a space to it wholly inadmissible in a report necessarily so general as this. On the sufficiency of the foundations depends, above all, the security and stability of the superstructure. The foundations may be originally solid or yielding, wet or dry, in stagnant or in running waters; or the materials of which they are composed may be of rock, scarped or floored, or of solid earth or gravel, or they may be of movable sands swept by the currents, or, finally, soft or yielding to unascertained depths, and incapable of sustaining any great weight. Each of these cases (and others not enumerated) requires its special mode of treatment, and all of them require experience, intelligence, and care in their management. Moreover, the plans and the process of erection of superstructures are liable to be modified and influenced by the character of the foundations; meaning by this word, the base, natural or artificial, upon which the superstructure rests. In some of the cases we have enumerated, there are characteristic difficulties which oppose themselves to the skill of the engineer, and which call for all the resources of his genius and experience. For all of them there have been devised general methods, by which they may be treated, but they all require to be modified in order to adapt them to special localities. It would not suffice, therefore, to prescribe general rules already well known to the profession. We should leave for the occasion, to competent engineers, the consideration of the peculiarities of the special cases, and the remedies applicable to them. To them they should be intrusted, under the control of some sufficient system of supervision.

We do not deem it necessary to speak at this time concerning the plastering, stuccoing, painting, or other superficial means of protecting or decorating the exterior or interior of light-houses; these may well be postponed to a future occasion. The lanterns, lighting apparatus, lightning rods, and other matters relating to the subject of construction, &c., not noticed in this part of the report, have been already discussed by the board, and will be found elsewhere in their report.

ILLUMINATION.

On a review of this subject, the board recommends the adoption, as early as practicable, of the lens system instead of that of reflectors, as most effective and economical.

They have shown, in a previous part of this report, that the Fresnel lens is essential for sea or lake-coast lights of the first order; that for those of the second order, or for secondary or beacon-lights, including the third, fourth, fifth, and sixth orders, the useful effect of a lens light is from 3.6 to 4 times that of reflector lights of the same class, *and that, economically, the reflector lights are four times as expensive for oil alone as the lens lights.*

It has been clearly shown, in discussing this matter, that if it were pos-

sible to convert in a moment all the present reflector lights of the United States into lens lights as nearly as possible (though, in almost every instance, they would be superior) of equal orders, the annual saving, for oil and other supplies, would be \$112,185 27, taking the appropriations of 1851-'52 as the basis of the calculation, with, at the same time, an increase of $3\frac{1}{2}$ to 4 times as much light from each lantern as at present.

If the estimates for 1852-'53 be taken as a basis, then the annual saving may be increased \$20,000, which will make the entire saving for one year, with all the advantages to be derived from superior lights, \$132,185 27.

Add to this sum \$40,000, the mean of the value of the lamps and reflectors proposed to be taken from the light-houses, to be fitted first with the lens apparatus, and which would be required, under any circumstances of improvement, for the forty-two light vessels already existing, and the sum of \$172,185 27 may be put down as clear profit, with which to purchase lens apparatus for the first year.

By appropriating this sum, or as much of it as can be economically and judiciously employed in improving the sea-coast lights, there will be an additional gain, at the end of the first year, in the difference in the cost of oil, &c., under the two systems, for all the apparatus procured with this saving. This saving will go on from year to year, on compound interest, at the rate of thirty to fifty per cent., until, in five or six years, should the appropriations be made as required to carry out gradually the system, we shall have lights equal to those of France and Great Britain in brilliancy, useful effect, and economy, *and apparatus that never requires renewing*, without, in the aggregate, having spent one cent more than would have been required for the ordinary service under the present system, with inferior lights and enormous sums for annual repairs and renovations.

These estimates are based upon the assumption that the sperm oil now in use is to be continued. Should it be decided, however, to follow the example of nearly the whole maritime world in introducing the colza or rape-seed oil, a saving of thirty-five to forty cents per gallon will be gained, equivalent to \$40,000 to \$45,000 more.

NOTE.—The price of the first-quality clarified colza oil is, on an average, at the principal markets in France, 72 francs the hectoliter, or for a little more than twenty-six gallons, which is equal to nearly $55\frac{1}{2}$ cents per gallon. Sperm oil, in this country, ranges from \$1 30 to \$1 50 per gallon, and it is doubtful if a *fair quality* can be furnished at these prices. The supply of the best sperm oil to stand a temperature of 28° Fahrenheit, is not equal to the demand, and no other quality should ever be burnt in a light-house. A few gallons of rape-seed oil has been sent from Havre to the board, costing about 60 cents per gallon.

This important agricultural product (rape-seed) only requires to be introduced favorably to the notice of our planters and farmers, to become a boon to the nation of no ordinary value. Adapted to the soils of nearly every portion of this great country, its admirable qualities for domestic illumination would soon bring it into favor, and, by its means, expel from our houses the many dangerous fluids now used for the sake *only of economy*.

The experiments made by Fresnel, Faraday, Stevenson, and other distinguished individuals, have proved, *beyond all question, that the colza is not only better than the best sperm oil*, (an article now very difficult to procure) *but that it will burn seventeen hours without coaling the wicks, that it will*

remain in a fluid state in a lower temperature than the best sperm oil, and that it is cheaper by nearly one-third.

In this country, the quantity of sperm oil, independently of its high price, has not been sufficient to meet the demands for the various purposes connected with steam machinery, &c., for several years. Lard and other prepared oils have been forced to take the place of it, for these and other purposes for which it is peculiarly adapted.

The returns from the fishing grounds show that this branch of commerce is becoming more and more uncertain, and less profitable, every year. When those engaged in the whale fisheries find it unprofitable, they will not pursue it because the government may require a few thousands of gallons annually. We cannot go wrong in this matter, in following the example of other countries.

France introduced the rape-seed oil, from conviction of its superiority. England, Scotland, Ireland, and the northern powers of Europe generally, have followed; first from motives of economy, and continue its use from the conviction that it is not only *more economical*, but is *better for light-house purposes than the best winter-strained sperm oil*, the only kind used in most lights. Olive-oil has been introduced into the light-houses of Liverpool, England, at a saving of forty per cent. over sperm oil. (Vide appendix H, No. 11, letter of Wm. Lord, esq.)

In the United States, the oil (two kinds, "winter and summer," being used) for our lights, is not of the best quality. It is now nearly fifty per cent. higher in price than it was a few years since; and with the present prospects, it must continue to increase in price so long as the demand is so great for it, as at present.

It has been proposed that the thirty-eight most important sea-coast lights should be fitted, with as little delay as possible, with first order lenses, and that the Argand lamps and reflectors taken from them (or such of them as may, upon examination, be found to be sufficiently good for that purpose) be used for fitting up the forty-two light-vessels now existing, which have been pronounced by high authority comparatively useless in their present state. Several years would be required to effect this change, as the new lights authorized by law, amounting to thirty-four, exclusive of those for the coasts of California and Oregon, require illuminating apparatus; and as there are only two establishments from which the lenses could be procured for some time at least, it would not be prudent to demand a larger number at once than could be easily supplied.

It is the opinion of this board, that with the authority of the law at present existing, if it be determined to abandon in good faith the reflector, and substitute the lens system in this country, a very small increase of appropriation for purchasing lenses for renovating existing light-houses, would suffice to effect a sufficiently gradual change; but as no lens apparatus has hitherto been introduced into the United States, except by special acts of Congress, although the authority to introduce the best illuminating apparatus has always existed, and as the board deem it of the first importance to introduce, without unnecessary delay, first-class lens lights at some of the most important points on our extended sea and lake-coast, they would urgently recommend a sufficient additional appropriation, to enable the Secretary of the Treasury to order apparatus for them at once. These lights will be spoken of more in detail in the general programme in this report. The government of France having a general supervision over the

fabrication of this apparatus, a fixed tariff of prices is published for every piece of which it is composed, which forbids the possibility of imposition on the part of the manufacturer. Under these circumstances, it becomes simply a matter involving length of time, and money, to effect the proposed change without detriment to the public interest.

Having fitted the most important sea-coast lights with the best lens apparatus, as well as the newly authorized lights, by changing thereafter such only of the minor lights as now, or hereafter, require new apparatus, would in two or three years place the light-house establishment of this country far in advance of its present state, in efficiency and economy.

To purchase Argand lamps and reflectors for the forty-two light-vessels, would be to retrograde in light-house illumination at a first cost of \$40,000 to \$45,000, and an annual waste of \$7,560 for oil alone; and of the supplies, to the extent to increase the amount to \$10,000, with apparatus which must be frequently renewed, producing only from one-fourth to one-sixth the usefulness of the less economical system, which never requires renewing.

Taking the estimate for 1852-3 for maintaining the lights of this country as a basis, the present system costs annually within a fraction of \$135,000 more than the same lights would under the lens system. But in so important and humane a branch of the public service as this is, upon the efficient and proper management of which depends, in a greater or less degree, the loss of human life and property, in which every individual in the land is to a certain extent interested personally, mere saving of money, which is by no means always true economy, should not be the only guide. The incalculable benefits to the seaman; the merchant, who receives the foreign products to gratify the wants of our citizens; the planter, who ships his cotton, tobacco, grain, breadstuffs, provisions, naval stores, and the thousands of products of our clime to the best markets, would seem sufficient to show the necessity for this change.

By those of our citizens along our southern coasts, from the mouth of Delaware bay to the Rio Grande, who are now and have ever been suffering in consequence of a badly lighted coast, will this additional reason be best understood and appreciated. Their freight lists and heavy insurances speak out truly on this point.

The \$7,000,000 worth of property sent into Key West, and there adjudicated for salvage, within the six years prior to January, 1850, (lost to our citizens and our government chiefly,) speaks trumpet-tongued on this subject. But this is not all. The wreck lists of Nassau and New Providence exceed by far those of Key West.

Let us light our coasts as France and Great Britain have done theirs, and wreckers will be compelled to turn their attention to other means of livelihood, and the consumers of every class and grade will pay less for their necessities and luxuries, and the planter, farmer, and mechanic will have smaller freight and insurance bills to pay on their exports.

If we assume the necessity for changing all of the lights on our coast to lens lights, and give to each one of them its proper power and efficiency, we should have about as follows :

Thirty-six first order lens lights, costing for apparatus-----	\$244,800 00
Ten second order lens lights, costing for apparatus-----	44,000 00
Sixty-one third order lens lights, costing for apparatus-----	113,460 00

Two hundred and six fourth, fifth, and sixth order lens lights, costing, in the aggregate, about-----	\$92,700 00
Total amount necessary to purchase lens apparatus for all the lights in the United States-----	494,960 00
Deduct value of reflectors and lamps for light- vessels at present existing, and for proposed ones-----	\$45,000 00
Deduct value of present illuminating apparatus, lamps, reflectors, chandeliers, &c., merely es- timating the value of the old silver, copper and iron, say 2,500 lamps and reflectors and 315 chandeliers, at one-fifth their cost-----	50,000 00
Deduct first year's saving on oil and other sup- plies-----	110,000 00
	205,000 00
Leaving at the end of the first year, with lenses, only a bal- ance of-----	289,960 00
Saving for four years-----	440,000 00
Making a gain, at the end of the fifth year, of-----	150,040 00

Thus, at the end of the fifth year the country will have gained \$150,000 in money, including interest, and an annual saving of \$110,000, the interest of which will make it \$117,600, and afford to the mariner lights equal to the best in the world, by which means every consumer and exporter will derive a pecuniary advantage; and those who go to sea, either from pleasure or necessity, will be doubly insured against shipwreck on our inhospitable coast.

To make the reform in our present light-house system perfect in its illuminating department, it only remains to introduce, in addition to the lenses, the colza or rape-seed oil, which will produce an additional saving, as has already been shown, of about \$10,000 per annum; making the grand total, in five years, of \$200,000. It may be contended that, inasmuch as interest is included in the saving, it is but fair to allow it on the first cost, which will be, at the end of the

Second year-----	\$15,397 60
Third year-----	8,797 60
Fourth year-----	2,197 60
Making for interest-----	26,392 80

still leaving a net gain, at the end of five years, of \$132,647 20, without taking into consideration the saving from the rape-seed oil, if introduced, which would increase it to \$182,647 20 of clear gain at the end of five years, in addition to the annual gain and other advantages already stated.

But if we continue to employ reflectors, such as we have now in use and are constantly introducing into our lights, *we will not only lose the amount annually which has been shown we should gain with lenses, but, in addition*

to that, these reflectors and lamps will require to be renewed once in ten to fifteen years, at a cost very little short of that of the lenses, which suffer no deterioration from long use, and humanity and commerce will continue to suffer for want of good and efficient lights on our coast.

INSPECTION.

The board is satisfied that without a rigid system of inspection by competent persons, the light-house system can never be efficient or economical. The whole sea and lake coasts of the United States should be divided into light-house districts, with less regard to geographical than to local lines. For example, the New York district should embrace all the lights from Watch Hill, including Block island, Montauk Point, &c., to the Highlands of Navesink, up the bays, and including the Raritan, Hackensack, Passaic and North rivers, to the head of navigation. The Philadelphia or Delaware bay district should embrace coast from the Barnegat to near Assateague, and up the Delaware on both sides to the head of navigation. The Baltimore or Chesapeake bay district should embrace all the coast from Assateague to Cape Henry, Hampton Roads and tributaries, and Chesapeake bay and tributaries, to the head of navigation. The other districts should be formed upon the same principles. In each of these districts there should be a local inspector, who should be furnished with the necessary means and facilities for regularly inspecting the lights, attending to the wants of the keepers, superintending small repairs, reporting the condition of the establishment, at short intervals of time, to the executive officer or engineer of the light-house board, superintend the placing, replacing and renovating buoys, beacons, &c., &c., under the general and special instruction of the light-house board, communicated through their executive officer or engineer.

For this purpose, there would be required on the lakes two inspectors, and on the Atlantic, Gulf, and Northwest coasts, including all the adjacent navigable waters, from ten to thirteen inspectors more, making the whole number required from thirteen to fifteen.

Each of these light-house districts should be placed under the charge of an active and zealous officer of the army or navy, who should receive all his instructions from, and be responsible to the light-house board, through their executive officer or engineer, and to whom all reports should be made.

The facilities for inspectors superintending such repairs, &c., &c., as may be confided to the local inspector, to be furnished by the light-house vessels, revenue cutters, and such other means as the Treasury Department may from time to time authorize the board to provide.

By this mode of inspection, very little if any additional expense will be incurred, while there will be secured an independent examination of every light on the coast, say from four to six times per annum, by a competent person, whose duty it will be to inform himself upon all essential matters connected with this service. In addition to the foregoing means, the revenue boarding-boats might and would be appropriately put in requisition, as occasion might require, to assist the inspector in his duties in situations where a strict economy would not authorize the employment of a vessel permanently to perform this service.

Instead of, as now, contracting with persons to keep the buoys in their

places for a certain sum per annum, and who seldom, if ever, perform the service faithfully, the inspector would, under proper instructions, be required to examine the bars, channels, &c., &c., of his district, at regular periods, and always immediately after heavy gales of wind to ascertain what buoys are out of position, and to replace them.

The inspecting officers would occasionally be accompanied by the secretary or engineer to the light-house board, or perhaps by both of them; a thorough system would be provided, which would inevitably be less expensive in the aggregate than that at present existing without specific law.

In connexion with these inspections, depots for stores, spare buoys, moorings, &c., &c., are indispensable in each district. These depots might in most places be at some place requiring but little annual expense, where the buoys and their moorings could be repaired, painted, &c., and where a spare light-vessel might be kept ready for use.

There should be at least one spare light-vessel for every three placed in exposed open sea-positions.

Duplicate buoys and moorings should be ready at all times.

The light-house board should have authority to cause buoys to be placed on newly-discovered shoals, wrecks, &c., &c., whenever necessary.

By the employment of these inspectors, the country would derive the benefit of their services without expense, and have an assurance, from their position and standing, of a faithful execution of their duties.

The board would refer again to the reports of the Committees of Commerce of the Senate and House already pointed out in this report, on this important branch of the lighting service.—(See Senate document No. 448, first session twenty-ninth Congress, &c., &c., in appendix.)

In connexion with this recommendation, the board would advise that light-keepers be examined, as naval engineers, midshipmen, and cadets are, in reference to qualifications for their appointments; that they should not be allowed to take charge of the lights without suitable preparation; nor the more important lights without proportionally higher qualifications; that such meteorological and tidal observations be required of them in addition to the keeping of suitable registers of lighting, consumption of supplies daily, &c., as may tend to test the capacity of the keepers, and to elevate the standard of information and practical skill of them as a class.—(Vide tidal, meteorological, and other instructions, in appendix.)

SUPERINTENDENCE.

An efficient provision of lights, and other aids to navigation, along our coast, competent light-keepers, and able and zealous inspectors, will not suffice to carry out perfectly the wise and humane designs of Congress and of the nation, unless there be provided a bureau or board in the department, thoroughly organized, charged with all the general and detailed duties of an administrative and executive character, appertaining to the light-house establishment.

To effect this highly important object without incurring additional expense, the board have recommended that a permanent board be authorized, under the name and style of the "light-house board," to be composed of civilians, military and naval officers, whose prerogatives and duties shall be defined by law, to be executed under the orders and direction of the Secretary of the Treasury; the members of said "light-house board"

to serve without other compensation than that now, or that which may hereafter be authorized by law, for their services in their respective civil and military offices held by them under the government. (See *ante* part of this report, page 17.)

GENERAL PROGRAMME

To guide legislation in extending and improving our present system of construction, illumination, inspection, and superintendence.

The seventh section of the act making appropriation for light-houses, light-boats, buoys, &c., approved March 3, 1851, provides, "That hereafter, in all new light-houses, in all light-houses requiring new lighting apparatus, and in all light-houses as yet unsupplied with illuminating apparatus, the lens or Fresnel system shall be adopted, if, in the opinion of the Secretary of the Treasury, the public interest will be subserved thereby."

The board are of opinion that this is a wise provision, and recommend that it be carried out to the letter, and in the spirit, by the department. There are very few cases, in the opinion of the board, where the public interest will not be greatly subserved by the substitution of the Fresnel lens for the reflectors now employed in illuminating our light-houses. In positions where the light is only required to illuminate a small arc of the horizon, it may be of questionable propriety; but in all such cases, the capable light-house engineer should decide upon the merits of the two kinds of apparatus. In no case requiring one-half or more of the horizon to be illuminated, is it believed reflectors ought to be employed, in preference to the lens. There may be occasionally circumstances of a paramount character, which may render the employment of reflectors preferable.

The ninth section of the act approved March 3, 1851, provides, "That the President be, and he is hereby required to cause to be detailed from the engineer corps of the army, from time to time, such officers as may be necessary to superintend the construction and renovation of light-houses."

The board are of opinion that this act is one calculated to produce the most beneficial results, in increasing the durability of light-house structures, and consequently lessening, to some extent at least, the present large annual appropriations for renovations and repairs; and they recommend that no new structure be erected, and no old ones be repaired, except under the superintendence of a competent officer of the corps of engineers.

The board are of opinion, that pending the action of Congress upon the subject of improving our lights, &c., much may be done towards introducing a more efficient and economical administration of the establishment, by a rigid adherence to the provisions of the seventh and ninth sections of the law of 1851.

The board are of opinion, that early and special attention should be given to these points, by those at present charged with the management of our lights, buoys, beacons, &c., &c.

LOCATING OF SEA AND LAKE COAST LIGHTS.

The board have adopted the same principle which has proved so effective in the organization of the French system of lights—namely, to place a sea-coast light of the first order, in general, every forty-two nautical miles, so

that, as a rule, one light will not be lost sight of until another is above the horizon. If it should be necessary to adopt only two main systems of distinction for these lights into fixed and revolving, then a fixed light should be placed between two revolving lights, suitably distinguished by flashes, &c., so that no two lights of the same kind should be nearer than eighty-four miles from each other. Other distinctions, easily described in the published lists, and easily comprehended by navigators, which would render all fear of mistakes arising from the want of proper distinctions illusory, (and without the use of colored media,) can be employed. (Vide distinctions employed in France, England, Scotland, and Ireland, in this report.) If, however, Mr. Babbage's system prove to be practicable, and be adopted, all doubt in regard to distinctions of light will be obviated. The board have adopted an approximate programme, in this report, for the sea and lake coast lights, the number of which is necessary to a full system. Of these many now exist, though not with the requisite range of visibility. (See lists A, B, C.) There are many locations where the wants of commerce will not require such lights for many years, though necessarily included in a general programme.

Provision should be made by degrees for converting the present lights into lens lights of the first order, placed on towers sufficiently high to give a range of at least twenty nautical miles, commencing with those of most importance to commerce, and taking also into consideration the present condition of the apparatus in the towers at present. Detailed lists of these lights are appended, marked A, B, C, and "Lake Coasts," and their importance may be considered in the order in which they stand.

List A, contains all the sea-coast lights at present existing, which require to be fitted with lenses of the first order, and arranged in the order of their importance.

List B, contains all the new proposed lights of importance, and relatively as they stand upon the list.

List C, contains all the sea-coast lights at present existing, which require to be made first order lens lights, and such as are necessary to be built to carry out the plan proposed by the board, in the order in which they stand along the coast. The detailed description of each locality will exhibit the relative importance of the lights on the several lists.

It is to be understood, of course, that distances between two adjacent sea and lake coast lights of major importance, will be varied, within the general rule, to suit circumstances of locality, importance of positions, &c., &c.

The board propose that the improvements and constructions of the new lights, contained in the lists A, B, and C, hereto appended, shall be gradual, taking them in their order of importance to the present state of commerce and navigation. Many of the proposed new lights on the Pacific coast, and of Florida and Texas, may not be required for many years. Those from the Dry Tortugas to Cape Canaveral are considered to be of the first importance, and should be authorized without unnecessary delay. The lights at the mouths of the Mississippi are second only to those from the Highlands of Navesink to Charleston, South Carolina.

A.

List of existing sea-coast lights which require to be elevated, and to be fitted with first order lens apparatus, arranged in their order of importance.

1. Cape Hatteras, North Carolina.
2. Cape Florida, Florida.
3. Dry Tortugas, Florida.
4. Cape Canaveral, Florida.
5. Cape Romain, South Carolina.
6. Fire Island inlet, Long Island, New York.
7. Cape Henlopen, Delaware.
8. Cape Henry, Virginia.
9. Gay Head, Massachusetts.
10. Montauk Point, Long Island, New York.
11. Barnegat, New Jersey.
12. Cape May, New Jersey.
13. Assateague, Virginia.
14. Cape Charles, Virginia.
15. Cape Lookout, North Carolina.
16. Cape Fear, North Carolina.
17. Charleston, South Carolina.
18. Tybee, Georgia.
19. Amelia island, Georgia.
20. Sapelo island, Georgia.
21. St. Augustine, Florida.
22. Pensacola, Florida.
23. Mobile Point, Alabama.
24. Northeast Pass, Louisiana.
25. Southwest Pass, Louisiana.
26. South Pass, Louisiana.
27. Cape St. Blas, Florida.
28. Chandaleur island, Louisiana.
29. St. Mark's, Florida.
30. Vermillion bay, Louisiana.
31. Truro, (Cape Cod,) Massachusetts.
32. Seguin's island, Maine.
33. Mount Desert Rock, Maine.
34. Thatcher's Island, Massachusetts.
35. Matinicus Rock, Maine.
36. Boone island, Maine.
37. Petit Menan, Maine.
38. Egmont Key, Tampa Bay, Florida.

B.

List of sea-coast lights proposed to be built, arranged in the order of importance with reference to time of construction, relatively one to another.

1. Gilbert's bar, (near Jupiter inlet, Florida,) first order lens.
2. Great West bay, Long Island, " "
3. Hillsborough inlet, Florida, " "
4. Dry bank, Florida, " "
5. 15 miles north of Indian river inlet, Fla., " "
6. Hunting island, South Carolina, " "
7. Musquito bar, Florida, " "
8. Currituck, (half-way between Cape Henry and
Body's island, " "
9. Absecum, (near Great Egg Harbor,) " "
10. Galveston bar, Texas, " "
11. Racoon point, Louisiana, " "
12. Matagorda island, Texas, " "
13. Brazos river, Texas, " "
14. Aransas pass, Texas, " "
15. Sabine bar, Texas, " "
16. Mermentua, Louisiana, " "
17. Brazos St. Jago, Texas, " "

PACIFIC COAST.

18. Point E. 5 N. of Farallon, first order lens,
19. Cape Mendocino, " "
20. St. Clemente, " "
21. St. Nicholas, " "
22. Point Esteros, " "
23. Cape Blanco, " "
24. Trinidad, " "
25. Cape Foulweather, " "
26. Cape Greenville, " "

ATLANTIC AND GULF COAST.

27. New River inlet, North Carolina, first order lens,
28. Cape Romano, Florida, " "
29. Charlotte harbor, Florida, " "
30. Cedar keys, Florida, " "
31. Red bluff, Florida, " "
32. Anslote keys, Florida, " "
33. Dead Man's point, Florida, " "

List of sea-coast lights existing and authorized by law to be built, and those required to render navigation safe and easy, from the northeastern to the Rio Grande boundary, on the Atlantic, and from the southern to the northern boundary, on the Pacific.

Ex. No. 5

Ex. No.	Location of light.	Distance. <i>Miles.</i>	Existing.	Remarks.
1	Petit Menan island	0	Fixed.	
2	Mount Desert rock	27	Do.	
3	Matinicus rock	33	Do....(2.)	
4	Seguin's island	39	Do.	
5	Boone island	46	Do.	
6	Thatcher's island, (Cape Ann)	30	Do....(2.)	
8	Cape Cod, (Truro)	43	Do.	
8	Sankaty Head	45	Flashing; second order lens; good.	
9	Gay Head	39	Revolving.	
10	Montauk Point, (Long Island)	48	Fixed.	
11	Great West Bay	33	.....	Required.
12	Fire Island inlet	33	Revolving.	
13	Navesink	37	Fixed and revolving (2;) lenses; good.	
14	Barnegat	38	Fixed.	
15	Absecum, (near Great Egg Harbor)	32	.....	Required.
16	Cape May	32	Revolving.	
17	Cape Henlopen	12	Fixed.	
18	Assateague	50	Do.	
19	Cape Charles, (Smith's island)	49	Revolving.	
20	Cape Henry	19	Fixed.	
21	Currituck, (half-way between Cape Henry and Body's island)	36	.....	Required.
22	Body's island	33	Revolving.	
23	Cape Hatteras	32	Fixed.	
24	Cape Lookout	61	Do.	
25	New River inlet	42	.....	Required.
26	Cape Fear, (Bald Head)	50	Fixed.	
27	Cape Romain	88	Do.	
28	Charleston	32	Revolving.	
29	Hunting island	33	.....	Required.

C—Continued.

No.	Location of light.	Distance. <i>Miles.</i>	Existing.	Remarks.
30	Tybee.....	83	Fixed.	
31	Sapelo island.....	46	Revolving.	
32	Amelia island.....	41	Fixed.	
33	St. Augustine.....	48	Do.	
34	Musquito bar, (half-way to Cape Canaveral)	48	.....	Required.
35	Cape Canaveral.....	48	Revolving.	
36	Indian River inlet, (north, 15 miles)	43	.....	Required.
37	Gilbert's bar, (near Jupiter inlet)	43	.....	Do.
38	Hillsborough inlet, (north, 9 miles)	43	.....	Do.
39	Cape Florida.....	43	Fixed.	
40	Carysfort reef.....	31	First order lens; good.	
41	Dry Bank.....	48	.....	Required.
42	Sand Key.....	50	First order lens; good.	
43	Dry Tortugas.....	54	Fixed.	
44	Cape Romano.....	0	.....	Required.
45	Charlotte Harbor.....	60	.....	Do.
46	Egmont island, (Tampa bay)	50	.....	
47	Ancloste Keys.....	42	Fixed.	Required.
48	Cedar Keys.....	50	.....	Do.
49	Dead Man's Point.....	42	.....	Do.
50	St. Mark's.....	46	Fixed.	
51	Cape St. Blas.....	65	Revolving.	
52	Red Bluff.....	55	.....	Required.
53	Pensacola.....	55	Revolving.	
54	Mobile Point.....	38	Do.	
55	Chandaleur's island.....	41	Fixed.	
56	Northeast Pass.....	54	Do.	
57	South Pass.....	10	Revolving.	
58	Southwest Pass.....	12	Two lights—one tower.	
59	Raccoon Point, (Ship island)	88	.....	Required.
60	Vermillion Bay.....	63	Revolving.	
61	Mermentau, (14 miles south)	46	.....	Required.
62	Sabine bar.....	46	.....	Do.

63	Galveston bar	do.....	55	Do.....
64	Brazos river	do.....	43	Do.....
65	Matagorda island, (Pass Caballo)	do.....	50	Do.....
66	Aransas Pass.....	do.....	50	Do.....
67	Brazos St. lagoon.....	do.....	100	Do.....
<i>Pacific coast.</i>				
68	San Diego, (Point Loma).....	California.....	0	Required.
69	St. Clement.....	do.....	65	Do.....
70	St. Nicholas	do.....	65	Required.
71	Point Conception	do.....	65	
72	Point Esteros.....	do.....	80	
73	Monterey	do.....	70	
74	Farallon	do.....	85	
75	Fort Point, (San Francisco)	do.....	28	
76	Point north from Farallon	do.....	65	Required.
77	Cape Mendocino.....	do.....	98	Do.....
78	Trinidad	do.....	50	Do.....
79	Cape Blanco	do.....	105	Do.....
80	Umpqua.....	Oregon.....	55	Required.
81	Cape Foulweather	do.....	60	
82	Cape Disappointment.....	do.....	95	
83	Cape Greenville	do.....	105	Required.
84	Cape Flattery	do.....	52	

In assigning positions for sea-coast lights on the Pacific, the plan of placing first order lights within the distance of forty-two nautical miles has not been followed, for want of more accurate and detailed geographical information.

Congress having authorized lights to be erected on a few of the most prominent and important points to aid the rapidly increasing commerce along that coast, which it is presumed will be fitted with appropriate lens apparatus, in conformity to the 7th section of the act of 1851, the board have only added the names of the remaining most prominent points of that coast to this list, leaving the more detailed wants of this branch of the public service to be developed by the operations of the coast-survey, now in rapid progress for external or sea-coast, and of population and interior communication for local lights.

Petit Manan light-house.

This is a fixed light, 53 feet above the level of the sea, situated on the south end of Petit Manan island, Maine, latitude $44^{\circ} 22' N.$, longitude $67^{\circ} 52' W.$ This light is fitted with twelve lamps and 15-inch reflectors, to illuminate the whole horizon. If the apparatus belonged to the first class instead of, as it does, to about the fourth, the greatest distance at which it could be seen, under the most favorable circumstances of weather, would be, from a vessel's deck fifteen feet, from the sea-level about thirteen miles. If we take into consideration the small size of the reflectors, and the small number of lamps for so large an arc of the horizon, it is fair to presume this light is seldom seen over ten miles. Distant from this light to the eastward are Seal islands, thirty-four miles, (two fixed lights,) and Gannet rock, (flashing light,) forty six miles, at the mouth of the Bay of Fundy, belonging to the British government. This light with a proper elevation and a lens apparatus would serve to guide vessels bound to any of the ports on the coast of Maine, from Frenchman's bay to Passamaquoddy bay, having the sea-coast lights of Seal island and Gannet rock to the eastward, and Mount Desert rock, distant twenty-seven miles to the southward and westward.

Mount Desert Rock light-house.

This light is on the keeper's dwelling, with an elevation of $56\frac{1}{2}$ feet above the level of the sea; it is fitted with twelve lamps and 21-inch reflectors, to illuminate the whole horizon. Latitude $43^{\circ} 58' 5'' N.$, longitude $68^{\circ} 08' W.$; it is situated about twenty miles SSE. of Mount Desert island; is twenty-seven miles distant from Petit Manan light, and thirty-three miles from Matinicus light, (two fixed lights.) This light with the best illuminating apparatus could not be seen, under the most favorable circumstances of weather, at a greater distance than fourteen miles. The small number of lamps for so great an arc renders it little better than a fourth order light, while its elevation can only give it the range of a light of that class.

A much greater elevation is required for this light, with the most powerful lens apparatus that can be constructed. Vessels bound from the eastward into any port from the neighborhood of Mount Desert, to Penobscot bay, would run for it; having made it as a first-class light, it would guide them into the ranges of the different harbor lights along the coast. From its isolated position at the distance of fourteen to eighteen miles from the

nearest land, it is one of the most important points on the eastern coast for a first-class light.

Martinicus Rock light-house.

These lights (two fixed) are situated on the rock south of Martinicus island, at the mouth of Penobscot bay. They are placed 40 feet apart, NNW. and SSE., on the keeper's dwelling. Each light has 14 lamps and 21-inch reflectors, at an elevation of 82½ feet above the level of the sea; 33 miles from Mount Desert rock and 39 miles from Seguin's island light, lat. 43° 46' 30" N., long. 68° 49' W. Its present range, under the most favorable circumstances of weather, would be, with good apparatus, 15 miles; but as the 14 reflectors are required to be placed on the frame in such a manner as to afford light to the whole horizon, it is not to be expected that it can be seen near so far.

This is an important light, and requires elevating; and, at the same time, a first order illuminating apparatus.

Seguin Island light.

This is a fixed light, 166 feet above the level of the sea, fitted with 15 lamps and 21-inch reflectors. This light is deficient in illuminating apparatus; with 24 lamps and 21-inch parabolic reflectors of the proper shape and finish, it could, under favorable circumstances of weather, be seen 18 to 19 miles. It is 39 miles from Martinicus rock light, 46 miles from Boone island light, and 21 miles from Monhegan and Cape Elizabeth lights. Lat. 43° 41' 36" N., long. 69° 44' W.

This is an important light, and only requires a first order apparatus to render it equal to all the requirements of navigation on this part of the coast.

Boone Island light.

This light is situated on the west part of the small low island bearing its name, off York river, Maine. It is fitted with 12 lamps and 15-inch reflectors, (fixed,) with an elevation of 70 feet above the level of the sea, in lat. 43° 08' N., long. 70° 29' W.

The greatest range with good apparatus, in good weather, would be 13 miles. The apparatus is defective, however, for so large an arc of the horizon. It is 46 miles from Seguin island light, and 30 miles from Thatcher's island lights. It requires increased elevation and first order apparatus.

Thatcher's Island lights.

These two fixed lights are situated about two miles off Cape Ann, fitted with 11 lamps and 21-inch reflectors, each, with an elevation of 90 feet; greatest range, 16 miles. Cape Ann forms the northern limits of Massachusetts bay. Distant from Boone island light 30 miles, Boston light 24 miles, and from Truro, Cape Cod, 43 miles. Lat. 42° 38' 21" N., long. 70° 34' 48" W.

This is a very important light-station, and the lights require to be increased in power and range.

Truro, Cape Cod, light.

This is an important sea-coast light, situated on the highlands outside of Cape Cod. It is 43 miles from Thatcher's island lights, 45 miles from Sankaty Head light, and 41 miles from Boston light. It is fitted with 15 lamps and 21-inch reflectors, (fixed,) with an elevation of 180 feet, giving it a range in good weather, if the apparatus is of the first order, of 20 to 21 miles. A first order lens is required for this tower. Lat. $42^{\circ} 02' 23''$ N., long. $70^{\circ} 03' 55''$ W.

Sankaty Head light.

This is a second order Fresnel flashing lens light.

It is placed on the southeast extremity of the island of Nantucket, with an elevation of about 150 feet above the level of the sea, which gives it a range of about 19 miles in ordinary states of the weather. It has been seen at a much greater distance, and is considered equal to the Highlands of Navesink lights, (first and second order lenses.)

In consideration of the dangerous navigation around the reefs and shoals off the island of Nantucket, it would have been advisable to have placed a first order lens in this tower; but the superiority of this light to those in its vicinity, renders it of doubtful propriety to propose any change in it.

Gay Head light.

This light is placed on the west point of Martha's Vineyard. It is a revolving light, fitted with ten lamps and 14-inch reflectors, having an elevation of 172 feet above the level of the sea.

This light is deficient in power, and not arranged to subserve the wants of the navigator. At the distance of about 12 miles it is obscured about three-fourths of the time. Its present elevation, with first order apparatus, would give it a range of 19 to 20 miles. Lat. $41^{\circ} 20' 54''$ N., long. $70^{\circ} 50' 26''$ W. Distant from Sankaty Head 39 miles, Montauk Point 48 miles, and Point Judith light 30 miles.

This light is not second to any on the eastern coast, and should be fitted, without delay, with a first order illuminating apparatus. A glance at the chart will suffice, to see its great importance.

Montauk Point light-house.

Lat. $41^{\circ} 04' 10''$ N., long. $71^{\circ} 51' 58''$ W. This is a very important light, especially for navigators bound from Europe to New York. It is fitted now with only 15 lamps and 21-inch reflectors for a fixed light. Its reported elevation is 160 feet above the level of the sea, and with a first order apparatus would be seen under ordinary circumstances about 20 nautical miles. Distant from Gay Head 47 miles; from Fire Island inlet light 66 miles. By erecting a light in the vicinity of Great West bay, Long Island, midway between Montauk Point and Fire island lights, the trade between New York and all ports to the eastward, including the whole of Europe, would be greatly benefited.

Light near Great West Bay, Long Island, New York.

It is proposed to erect a first-class light on Long Island, midway between Montauk Point and Fire Island inlet, distant 33 miles, to facilitate navigators going to and coming from the eastward.

The letters of packet and other shipmasters, in appendix B, will show conclusively the necessity for a light in this vicinity.

Fire Island Inlet light-house, Long Island, New York.

This is a most important light to navigators trading to New York. It may be said to mark the eastern entrance to the bay of New York.

It is situated on the south side of Long Island, New York; east side of Fire Island inlet; lat. $40^{\circ} 37' 46''$ N., and $73^{\circ} 13' 38''$ W. long.; distant 37 miles from the Highlands of Navesink, which mark the western entrance to the bay of New York. This tower has an elevation of only 89 feet 3 inches, and has only 14 lamps and 21-inch reflectors for a revolving light. The range of this light, with its present elevation and the best apparatus that could be procured, would not exceed $14\frac{1}{2}$ nautical miles in ordinary weather. It is therefore clearly necessary to increase its height, and place in the tower the most powerful lens apparatus that can be procured.

Highlands of Navesink lights, New Jersey.

There are two towers and lights at this station; a first order fixed, and a second order revolving lens apparatus. The great importance of the lights on this point renders it highly necessary, in carrying out the proposed plan of improving and increasing the number of sea-coast lights, that the second order apparatus should be changed for a first order one. These lights are now the best on the coast, but are not, when combined, equal to better than a second order lens light. With the present elevations of these lights above the level of the sea, and the substitution of a first order lens for the second order apparatus, navigators would be warranted in running boldly for them, and with the certainty of seeing them, under ordinary circumstances, at the distance of 22 nautical miles.

Barnegat light-house.

This is a light in point of importance equal to that of Fire Island inlet. It is situated 37 miles from the Highland lights, on Long Beach, New Jersey, on the south side of Barnegat inlet. At present it is fitted as a fixed light, with 11 lamps and 14-inch reflectors, equal in power to about a fifth order lens light. The numerous wrecks, involving the great loss of life and property, attest the truth of the necessity for making this a first class sea-coast light. The tower is 40 feet high, placed on a low beach, giving it a range of probably $11\frac{1}{2}$ nautical miles. The improvement of the Montauk, Fire island, and Barnegat lights, and the erection of a first class light near Great West bay, Long Island, would render the approaches to New York bay much safer than they are at present, and would save to our government and to our citizens many millions of dollars' worth of property, and prevent the untimely loss of many valuable lives.

Absecum Beach, New Jersey.

A sea-coast light is evidently necessary in this vicinity to guide vessels, bound north, clear of the Absecum and Brigantine shoals. The coast here is very low and difficult to distinguish, and the light on Tucker's beach, near Little Egg Harbor, although fitted with 15 lamps and 15-inch reflectors, showing a fixed red light, from its little elevation ($39\frac{1}{2}$ feet) is not seen farther than 5 to 8 miles; in addition to which, the woods on the Absecum beach, to the southward, hide it from the mariner going north.

A light should be placed somewhere in this vicinity, west of the inlet, and as nearly midway between Barnegat and Cape May light as possible.

An examination of this coast by competent professional persons can alone decide the best site for a sea-coast light.

Cape May light-house, New Jersey.

The position of this light on the east side of Delaware bay, and its contiguity to the dangerous bank known to navigators as the "Five-fathom bank," renders it of great importance that it should be of the first order. This is a revolving light, 88 feet above the level of the sea, fitted with 15 lamps and sixteen-inch reflectors. This light has been shown to be inferior to the third order lens light on Brandywine shoal, in the proportion of 3 to 1. Its present range under the most favorable circumstances of weather is not greater than fourteen and a half nautical miles, and with the present apparatus it is doubtful if it can be seen so far by several miles.

Make Cape May and Henlopen lights first order lights, with proper elevations, and navigators will be able to place their vessels in positions for receiving pilots without the risk of shipwreck on the dangerous "Five-fathom bank," distant sixteen miles from Cape May, and twenty miles from Cape Henlopen. With bearings from these two lights, seen at the distance of twenty to twenty-five miles, the navigator could always shape his course by the most direct line into the bay, or for the breakwater. The light vessel authorized by law to be placed on the "Five-fathom bank," is so often out of position, that it is the more important that these improvements should be made.

Cape Henlopen light-house.

This is one of the best reflector fixed lights on the coast, although inferior to the third order lens on Brandywine shoal, in the proportion of 1 to 6. This light has an elevation of one hundred and eighty feet, and only requires a first order lens apparatus to make it equal to the requirements of commerce and navigation.

The large amount of trade from Philadelphia warrants the proposed expenditure, and humanity would seem to dictate it as consistent with true policy and philanthropy.

Assateague light-house, Va.

This light is situated on Assateague island, between Capes Henlopen and Charles, in latitude $37^{\circ} 54' 36''$ N., and longitude $75^{\circ} 21' 45''$ W.; a fixed light, fitted with only eleven lamps and fourteen-inch reflectors,

The shoals off this low and dangerous coast render the improvement of this light one of paramount importance. By elevating this tower to 150 feet, and placing in it a first order lens apparatus, there will be no great necessity for any other sea-coast light until we reach Cape Charles, (Smith's island.) The very dangerous shoals extending along this entire coast at a considerable distance from the low coast, at distances ranging from five to twelve miles, as shown from the recent surveys by the coast survey, make it the duty of the government to cause this light to be increased in power and range to the rank of the first-class sea-coast light, without delay.

Smith's Island light-house, Cape Charles.

This light is placed on the NE. of Cape Charles, and at the north entrance of Chesapeake bay. This very important light has at present only ten lamps and twenty-one inch reflectors. The dangers at the entrance to Chesapeake bay render it extremely important that this light should be increased to a first order one. The tower has an elevation of only fifty-five feet, placed on a very low coast, giving the light, if in other respects good, a range of not more than twelve nautical miles, which it can seldom reach in consequence of the very inferior illuminating apparatus. This is one of the lights requiring the earliest attention of the light-house department.

Cape Henry light-house, Va.

This is one of the best reflector lights on the coast. It is situated on the south side of the entrance to Chesapeake bay, has an elevation of 120 feet, and is fitted with eighteen lamps and twenty-one inch reflectors. It being a prominent leading mark for vessels bound into Chesapeake bay, Hampton roads, and their numerous tributaries, every argument would seem to be in favor of its speedy improvement, to render it equal to the best first-class lights of other maritime nations.

Light-house half way between Cape Henry and Body's island light.

The large number of shipwrecks and the vast amount of life and property lost annually on this coast, should be a sufficient reason for erecting and maintaining a first-class sea-coast light on some eligible site in this vicinity.

The Body's island light is badly located, and insufficient in power and range to subserve fully the requirements of commerce and navigation. Vessels bound south from the eastward run to make this coast, with the view to avoid the opposing currents of the Gulf-stream, and at the same time to avail of the favorable currents within the limits of the cold wall bounding the Gulf-stream. The trend of the coasts on either side of the Chesapeake bay renders navigation more dangerous than it would otherwise be, and therefore it becomes the more important to light well the entire coast from Cape Hatteras to Cape Henlopen.

Body's Island light-house, North Carolina.

This light has already been referred to. It is of great importance especially to the coasting trade, and would be of much more, if it were increased to a first-class light. It is now fitted with fourteen lamps and twenty-one

inch reflectors, revolving, with an elevation of fifty-six and a half feet, giving it a range of about twelve nautical miles. This, in addition to the proposed sea-coast light between it and Cape Henry, would, if properly fitted, save the life of many a gallant seaman, and millions of dollars' worth of property to the country.

Cape Hatteras light-house, North Carolina.

• There is perhaps no light on the entire coast of the United States of greater value to the commerce and navigation of the country than this. That it is not such a light as any sea-coast light should be, is too apparent to require much argument; while its special requirements, having reference to the Gulf-stream, the currents and counter-currents which sweep past it, and the very dangerous shoals, extending to the distance of ten nautical miles from the light, all tend to make it one of no ordinary importance. Vessels, propelled both by wind and steam, run for soundings off this cape; and it is of the first importance to navigators wishing to make quick passages, that they should see this light in going south. At present it is of very little use, in consequence of its limited range. Navigators do not, as a general rule, rely upon it sufficiently to warrant them in running for it. It is fitted with fifteen lamps and twenty-one inch reflectors, having an elevation of about ninety-five feet, which would give it a range, under favorable circumstances, of fourteen and a half nautical miles, provided the apparatus for illuminating was of the best description.

There is no single light on the coast believed to require renovation more than this does. An elevation of one hundred and fifty feet, and a first-class illuminating apparatus, are imperiously demanded, and without any unnecessary delay. (See letters from navigators, in appendix B; especially from commanders of sea-steamers running to and from Chagres.)

Cape Lookout light-house, North Carolina.

This is at present a fixed light, fitted with thirteen lamps and twenty-one inch reflectors, and elevated ninety-five feet above the level of the sea.

In consideration of the manner in which navigators have to follow this low coast, this light becomes, necessarily, one of the important sea-coast lights, and requires to be elevated and improved to that extent. The shoals off this cape are of such a character as to render it a very important light.

New River Inlet, North Carolina.

• The great distance from Cape Lookout to Cape Fear, and the dangerous shoals extending to such a great distance from them, without any prominent mark intervening to guide navigators, render it necessary, in making up a general plan for lighting the entire sea-coast, to include a first-class light, to be placed somewhere in the vicinity of New River inlet. The coast between Capes Hatteras and Fear forms a curve, but not to such a degree as to render a light near this point unnecessary. Although the necessity for this proposed light may not be considered as pressing, yet in a well-devised scheme it cannot be entirely omitted.

Bald Head, Cape Fear, North Carolina.

This light, in its present position and with its present apparatus, &c., is comparatively useless.

The apparatus, 15 lamps and 21-inch reflectors, is inadequate to the requirements of the service of an ordinary seacoast light, while this is one of the special cases requiring extraordinary means to insure any amount of good. The tower is nearly four miles from the pitch of the cape, and twenty nautical miles from ten fathoms water, in a direct line on the end of the "Frying Pan shoals," which extend continuously from the pitch of the cape. The assumed elevation of the light is 110 feet, which, with good illuminating apparatus, would give a range, under the most favorable circumstances, of 17 to 17½ nautical miles. Careful observation has, however, shown that it is very seldom seen twelve miles; and then only resembling a star of the fifth or sixth magnitude. This light is considered by the pilots as of very little, if indeed of any use at all, for the local purposes of the harbor; while it is perfectly clear that it is of no value to the navigator in guiding him around and clear of these shoals, which, in the opinion of navigators, are only exceeded in importance by those off Nantucket.

This light should either be reduced to a mere harbor light or removed to the pitch of the cape, and given an elevation sufficient to insure a first order light being seen, under ordinary circumstances, outside of the shoals.

This light as a first class seacoast light, and a first-class light-vessel placed on the shoals, would tend greatly towards increasing the safety of navigation.

Cape Romain, South Carolina.

The dangerous shoals off this point render this an important light to navigators bound to Charleston, and as far south as St. Augustine. To save the current and to keep out of the influence of the current of the Gulf-stream, navigators run for soundings off the Cape Romain shoals. A first-class light would tend greatly to lessen the hazards of this navigation. The present light, fitted with only 11 lamps and 21-inch reflectors, at an elevation of only 87 feet, cannot be seen with any degree of certainty at a greater distance, under the most favorable circumstances, than about 14 nautical miles, which is by no means far enough to enable navigators to run their vessels with that boldness which is essential to success. This light in point of power, brilliancy and range, is not superior to a fourth order lens.

Charleston light-house, South Carolina.

This important light is fitted with only 12 lamps and 21-inch reflectors; revolving, with an elevation of about 125 feet. Its greatest range about 16 miles.

The necessity for a first order lens apparatus for this light is too apparent to require more than a bare reference to the chart. This light should be changed to a fixed light, and the lights on either side of it changed in their characteristic distinctions, for the reason that it is used as a range with the beacon-light for crossing the bar. Revolving lights are not adapted to this purpose, especially where channels are narrow and the eclipses of long duration.

Hunting Island, Georgia.

This point is one of the positions selected for new lights in carrying out the general programme. Distant 33 miles from Charleston, South Carolina, and about midway between the Charleston and Tybee lights.

Tybee light.

This is an important light both in a general and local point of view. For the oversea voyager along the coast, it is of equal importance to those generally on the coast for local purposes, as the guide to the entrance to Savannah river. This light at present is fitted with 15 lamps and 16-inch reflectors, and has an elevation of 100 feet. This light, in consideration of the sameness in the appearance of the coast, should be well distinguished and improved to the extent of making it a first order light.

Sapelo Island light-house.

This light is forty-six miles from Tybee light, and comes into the list embracing the general programme. As a sea-coast light, its importance will appear clearly by referring to the chart, and in a local point of view it is the mark to guide vessels into the important inland-waters constituting Doboy sound. This is at present a light fitted with fifteen lamps and 15-inch reflectors, elevated seventy-four feet above the level of the sea, and is revolving. Its greatest range now, will not exceed thirteen and a half nautical miles. As a sea-coast light, it should be seen clearly and distinctly at the distance of twenty nautical miles.

Amelia Island light-house, Florida.

This light, forty-one miles from Sapelo light-house, is another of the proposed sea-coast lights. It is at present fitted with fourteen lamps and 15-inch reflectors; a revolving light, having an elevation of about sixty feet, and a consequent range for the best description of apparatus, of thirteen nautical miles. The tower requires to be elevated, and in other respects improved, to the extent of making it a first-class sea-coast light.

St. Augustine light-house.

This light, being fifty miles from the Amelia island light, is included in the list of sea-coast lights. The present light is one of a merely local character, being fitted with only ten lamps and small reflectors.

Musquito Bar.

A light is proposed to be placed in this vicinity. Although its immediate necessity is not apparent, yet in time it will become necessary to erect a sea-coast light half-way between St. Augustine and Cape Canaveral. This point is fifty miles from St. Augustine, and forty-three miles from Cape Canaveral.

Cape Canaveral.

This is one of the prominent points on the coast, requiring the most powerful sea-coast lights to facilitate navigators. Dangerous shoals extend to a considerable distance off this cape, rendering it still more important that a first order light should be substituted for the present very inefficient one.

The present apparatus consists of fifteen lamps and 21-inch reflectors,

revolving, in a tower of only fifty-five feet elevation. The present range of this light does not exceed twelve nautical miles, and should be increased to not less than twenty nautical miles.

Cape Florida.

Between this and Cape Canaveral it is proposed to erect three new sea-coast lights of the first order; one near Jupiter inlet is considered of immediate importance; and the other two at different periods, according to circumstances, and as the expenditures for light-house service on other points may warrant.

The Cape Florida light, marking, as it does, a prominent point on a most dangerous coast, should necessarily be of the most powerful illuminating apparatus. The present apparatus is composed of seventeen lamps and 21-inch reflectors, with an elevation of seventy feet above the level of the sea, giving a range of not more than thirteen nautical miles. The currents and dangerous reefs along the Florida coast, render it of absolute importance that it should be increased to the rank of a first-class sea-coast light.

Carysfort Reef and Sand Key lights.

These two important lights are now in course of construction by the officers of the topographical engineers, to be fitted with first order lens apparatus.

Dry Bank.

This position has been selected as an intermediate point for a first-class light mid-way between Carysfort Reef and Sand Key lights, at the distance of forty-eight miles from them. It is believed to be of the first importance that the entire Florida coast should be lighted with the lens apparatus of the greatest power, without delay.

Dry Tortugas.

This is a very important light, especially to those navigators bound to and from the Gulf of Mexico. It is fitted at present with seventeen lamps and 21-inch reflectors, with an elevation of seventy feet, giving a range of about thirteen nautical miles. This light is fifty-five miles from Sand Key, which makes it still more important that it should be of the first order.

Pensacola light-house.

This light is deficient in power, being fitted with only ten lamps and sixteen-inch reflectors. This and the light at Mobile Point, being about forty miles apart, are both revolving.

As an important naval station, Pensacola requires a first-class seacoast light. The present light is very little better than the ordinary local lights along the coast. The distinction of this light should be changed, as it is liable to be mistaken for the one at Mobile Point.

The proposed lights along the Florida coast, from the Keys and Dry Tortugas to Pensacola, &c., although necessary in a general plan, are not

inch reflectors, revolving, with an elevation of fifty-six and a half feet, giving it a range of about twelve nautical miles. This, in addition to the proposed sea-coast light between it and Cape Henry, would, if properly fitted, save the life of many a gallant seaman, and millions of dollars' worth of property to the country.

Cape Hatteras light-house, North Carolina.

• There is perhaps no light on the entire coast of the United States of greater value to the commerce and navigation of the country than this. That it is not such a light as any sea-coast light should be, is too apparent to require much argument; while its special requirements, having reference to the Gulf-stream, the currents and counter-currents which sweep past it, and the very dangerous shoals, extending to the distance of ten nautical miles from the light, all tend to make it one of no ordinary importance. Vessels, propelled both by wind and steam, run for soundings off this cape; and it is of the first importance to navigators wishing to make quick passages, that they should see this light in going south. At present it is of very little use, in consequence of its limited range. Navigators do not, as a general rule, rely upon it sufficiently to warrant them in running for it. It is fitted with fifteen lamps and twenty-one inch reflectors, having an elevation of about ninety-five feet, which would give it a range, under favorable circumstances, of fourteen and a half nautical miles, provided the apparatus for illuminating was of the best description.

There is no single light on the coast believed to require renovation more than this does. An elevation of one hundred and fifty feet, and a first-class illuminating apparatus, are imperiously demanded, and without any unnecessary delay. (See letters from navigators, in appendix B; especially from commanders of sea-steamers running to and from Chagres.)

Cape Lookout light-house, North Carolina.

This is at present a fixed light, fitted with thirteen lamps and twenty-one inch reflectors, and elevated ninety-five feet above the level of the sea.

In consideration of the manner in which navigators have to follow this low coast, this light becomes, necessarily, one of the important sea-coast lights, and requires to be elevated and improved to that extent. The shoals off this cape are of such a character as to render it a very important light.

New River Inlet, North Carolina.

• The great distance from Cape Lookout to Cape Fear, and the dangerous shoals extending to such a great distance from them, without any prominent mark intervening to guide navigators, render it necessary, in making up a general plan for lighting the entire sea-coast, to include a first-class light, to be placed somewhere in the vicinity of New River inlet. The coast between Capes Hatteras and Fear forms a curve, but not to such a degree as to render a light near this point unnecessary. Although the necessity for this proposed light may not be considered as pressing, yet in a well-devised scheme it cannot be entirely omitted.

Bald Head, Cape Fear, North Carolina.

This light, in its present position and with its present apparatus, &c., is comparatively useless.

The apparatus, 15 lamps and 21-inch reflectors, is inadequate to the requirements of the service of an ordinary seacoast light, while this is one of the special cases requiring extraordinary means to insure any amount of good. The tower is nearly four miles from the pitch of the cape, and twenty nautical miles from ten fathoms water, in a direct line on the end of the "Frying Pan shoals," which extend continuously from the pitch of the cape. The assumed elevation of the light is 110 feet, which, with good illuminating apparatus, would give a range, under the most favorable circumstances, of 17 to 17½ nautical miles. Careful observation has, however, shown that it is very seldom seen twelve miles; and then only resembling a star of the fifth or sixth magnitude. This light is considered by the pilots as of very little, if indeed of any use at all, for the local purposes of the harbor; while it is perfectly clear that it is of no value to the navigator in guiding him around and clear of these shoals, which, in the opinion of navigators, are only exceeded in importance by those off Nantucket.

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The Cape Florida light, marking, as it does, a prominent point on a most dangerous coast, should necessarily be of the most powerful illuminating apparatus. The present apparatus is composed of seventeen lamps and 21-inch reflectors, with an elevation of seventy feet above the level of the sea, giving a range of not more than thirteen nautical miles. The currents and dangerous reefs along the Florida coast, render it of absolute importance that it should be increased to the rank of a first-class sea-coast light.

Carysfort Reef and Sand Key lights.

These two important lights are now in course of construction by the officers of the topographical engineers, to be fitted with first order lens apparatus.

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Dry Tortugas.

This is a very important light, especially to those navigators bound to and from the Gulf of Mexico. It is fitted at present with seventeen lamps and 21-inch reflectors, with an elevation of seventy feet, giving a range of about thirteen nautical miles. This light is fifty-five miles from Sand Key, which makes it still more important that it should be of the first order.

Pensacola light-house.

This light is deficient in power, being fitted with only ten lamps and sixteen-inch reflectors. This and the light at Mobile Point, being about forty miles apart, are both revolving.

As an important naval station, Pensacola requires a first-class seacoast light. The present light is very little better than the ordinary local lights along the coast. The distinction of this light should be changed, as it is liable to be mistaken for the one at Mobile Point.

The proposed lights along the Florida coast, from the Keys and Dry Tortugas to Pensacola, &c., although necessary in a general plan, are not

deemed to be of present great importance. With the increase of trade and population, the coast must keep pace in its improvements in lighting.

Mobile Point.

This is believed to be the best reflector-light on the coast; being revolving, and fitted with twenty-one lamps and twenty-one inch reflectors. The elevation of this light being only fifty-five feet, its range is necessarily restricted within the very narrow limits of only twelve nautical miles. This light, from a proper elevation, could be seen at a distance of eighteen to twenty miles. This tower should be elevated to at least 125 feet, to render the light of as much importance as the navigation interests of Mobile demand. This light may be easily mistaken for the one at Pensacola, and therefore the characteristic distinction of one of them should be changed.

In carrying out the general plan, it may become a question as to whether Mobile Point or Sand island light should be the principal or seacoast light.

Passes of the Mississippi.

These lights should be of the first class, with such elevations as will give them the ranges of at least twenty nautical miles.

The present lights are inefficient, and unnecessarily expensive, without any commensurate benefits. These lights are of great importance to the commerce of the Gulf of Mexico, and should be rendered the most efficient in the shortest space of time.

The remaining lights along the coast, embraced in the programme, are of minor importance, compared to those already enumerated; but deserve the attention of those who are, or may be, charged with the light-house service. Many of the points along the coast of Texas require lights, especially at the entrances to the ports and bays, at an early day.

The prominent points on the Pacific coast should have lights without unnecessary delay, and no seacoast light should be fitted except with first-class apparatus.

LAKE COAST.

Champlain, Ontario, Erie, Huron, Michigan, Superior, and their tributaries or connecting links.

The shores of these inland seas belonging to the United States, are, so far as the number of the lights is concerned, pretty well lighted. There are a few important points which require lights of greater power and range than those now existing; and as commerce and navigation increase there, a few additional small lights may be required, to the extent probably of six in Michigan, one in Ontario, three in Huron, and several in Superior.

The most of these lights are mere pier-head beacons. A system arranging the lights into classes, and giving to each one a distinctive characteristic, is necessary.

In Lake Huron, the two important lights of Thunder Bay island and Point aux Barques, distant about twenty-two miles, and marking the entrance to Saginaw bay, are both fixed.

Many of these lake lights have more lamps and reflectors, although only requiring to have short ranges, than many sea-coast lights on the Atlantic and Gulf coasts.

Galloo island, east end of Lake Ontario, near the river St. Lawrence, is fitted with fifteen lamps and reflectors; in Lake Superior, Manitou island, fifteen lamps and reflectors; White Fish Point, thirteen; and Copper Harbor, thirteen lamps and reflectors.

These principal lights on the lakes should be fitted with third order lenses, of smaller or larger model, according to circumstances, similar to the one recently placed in the Wagooshance light, built under the direction of the Topographical Bureau.

The following may be considered first-class lake lights, and should be of the third order lens apparatus, viz :

Galloo island, Lake Ontario,	fixed.
Sodus bay, do.	revolving.
Fort Niagara, do.	fixed.
Dunkirk, Lake Erie,	do.
Presq'isle, do.	do.
Cleveland, do.	do.
Western Sister, do.	do.
Buffalo, do.	do.
Point aux Barques, Lake Huron,	fixed.
Thunder Bay island, do.	do.
Presq'isle, do.	revolving.
Point de Tour, do.	fixed.
Wagooshance, Lake Michigan,	third order lens.
Fox isles, do.	required.
South Manitou island, do.	fixed.
Milwaukie, do.	do.
Chicago, do.	do.
White Fish point, Lake Superior,	do.
Copper Harbor, do.	do.
Manitou island, do.	do.

Of the seventy-two lights on the lakes and their tributaries, sixty-eight are fixed and four revolving.

ARRANGEMENT INTO ONE SYSTEM IN REFERENCE TO CLASSIFICATION.

The board recommend the following classification of lights, according to their positions, uses, &c., &c.

1. Main coast lights for the most prominent points on the coast.
2. Secondary lights for the inferior points on the coasts, and in broad sounds, bays, &c.
3. Minor sounds and bays, and for harbor and river lights.
4. Range, beacon, and pier lights.

Also into six classes, according to the dimensions of the lighting apparatus and the range of the lights.

All the main sea-coast lights should be of the first order, and the classes to which the secondary, sound, bay, harbor, river, range, beacon, and pier lights should belong, would be determined by the light-house board, according to the locality, objects for which placed, &c., &c. This

applies to new lights, and to the gradual replacing of the old ones as they may require renewal.

It is believed that many of the present lights might be dispensed with if effective ones were substituted for those now placed on important points, but not of sufficient power and range, which would in the end produce a considerable saving.

DISTINCTIVE CHARACTERISTICS.

The experiments of the board will enable them to make positive recommendations in regard to this important subject. The light-houses and vessels, as well as the lights, should be distinguished from each other by sight, as well as, in case of fogs, by sound.

Colors should only be used for distinguishing small lights of short range, as river, pier, beacon, or range lights. In employing colored media at all for lights, it is important that the most approved modes, with the best quality of appliances, only be used; a duty which should devolve upon professional men.

Mr. Stevenson enumerates the number of distinctions, of which reflecting lights are susceptible, as nine: First, fixed; second, revolving white; third, revolving red and white; fourth, revolving red with two whites; fifth, revolving white with two reds; sixth, flashing; seventh, intermitting; eighth, double fixed light; ninth, double revolving white lights; to which may be added, tenth, double, one fixed and one revolving. Of these, three depend on color and should be discarded, reducing the distinctions to seven.

In the Scottish lights, by causing a rapid revolution of the frame, and placing the rims of the mirrors of each side in one vertical plane, while their axes are in a plane inclined to the vertical, flashes are produced every five seconds, which appear to rise and sink. The intermitting light suddenly appears, is steady for a short time, and then disappears suddenly. These changes are produced by the vertical motion of circular shades in front of the reflectors.

The different characteristic combinations in the lens system, according to M. L. Fresnel, are nine: First, flashing at the interval of a minute; second, flashing at the interval of half a minute; third, white and red flashes alternating; fourth, fixed lights flashing every five minutes; fifth, flashing every three minutes; sixth, every two minutes; seventh, fixed white lights with red flashes; eighth, fixed white lights; ninth, double fixed lights. These are applied only to the first three orders of lights.

In England the lights are classified as sea-coast, secondary, and harbor and river lights.

In France they are divided into six orders, according to their range and the size of the lighting apparatus; the first order being the largest, and the second, third, and fourth orders being each divided into two classes, the larger and smaller, or first and second classes.

The objections to colored lights are, the large absorption of the incident light, and the difficulty of distinguishing the color. Red is admitted to be the best color. A good red light is seen sixteen miles, and sometimes twenty-two. Green lights from a powerful apparatus, in Mr. Stevenson's experiments, were seen seven miles in very clear weather, and blue lights only five.

The objections to red, are—

1. The great loss of light by absorption. A full red glass used as a chimney of a lamp, absorbed eighty per cent. of the whole. A pink French glass absorbed but fifty-seven per cent. of the light, but the light was not characteristic.

2. White lights grow reddish in a fog. In a revolving light, showing alternately red and white, the red is absorbed at a less distance than the white, and the light may be mistaken for a white light of half the period of revolution.

Two lights will appear blended in one, which are not separated by at least $3' 18''$; call H the required distance between the lights in feet, Δ the observer's distance in feet, θ half of $3' 18''$. Then $H = 2 \Delta \tan. \theta$. For one mile, $H = 5.84$ feet, and for n miles $H = n \times 5.84$.

Leading, or range lights, should be nearly on the same elevation, so as to cause them to appear nearly, but not quite in one. The distance between them should not be less than one-sixth of the distance at which they are thus to be used.

In forming a programme for lighting the coast, the following conditions should be realized:

1. The most prominent points should be first lighted.
2. Revolving lights, as more powerful than fixed, should be used, when possible, on the projecting points.
3. Lights identical in appearance should not occur within eighty to one hundred miles of each other.
4. Distinctions of color should not be adopted, except in cases of absolute necessity.
5. As few lights as possible should be used, not only for the sake of economy, but to avoid confusion.
6. Distinctions of lights depending on the estimations of small differences of time, of appearance and disappearance, should never be resorted to.
7. Harbor or local lights should generally be fixed, and may be distinguished by colors.
8. Floating lights should never be used, when fixed lights can be employed.

The system proposed by Charles Babbage, esq., of London, and which has been communicated by its distinguished author to the board, at the request of one of its members, is to distinguish lights by occultations; or, to make each light-house repeat its own number continually during the whole time it is lighted.*

This is accomplished by enclosing the upper part of the glass cylinder of the Argand burner, by a thin tube of tin or brass, which, when made to descend slowly before the flame, and then allowed suddenly to start back, will cause an occultation and reappearance of the light.

The number belonging to a light-house may be thus indicated to distant vessels. Take as an example, 243.

1. Let there be *two* occultations.
2. A short pause.
3. *Four* occultations.

* Communication from Charles Babbage, esq., to the light-house board, (appendix BB.) The board were indebted for an early notice of this ingenious and important proposition, to Dr. B. A. Gould, of Boston, who kindly described it, and forwarded a proof-sheet of the chapter in Mr. Babbage's work on the London Exposition, which contains a notice of it.

4. A short pause.
5. *Three* occultations.
6. A longer interval of time.

This system of occultations may be repeated all night by means of proper mechanism.

The rapidity of the occultations themselves, the length of the pauses between the units and tens and between the tens and hundreds, as well as the duration of the long interval of time which marks the termination of the number, must be made the subject of experiment.

A light has been already used as an illustration, in which the occultations occurred at intervals of one second; the pauses occupied four and the long interval ten seconds. The pause was thought to be unnecessarily long, and was diminished. Whatever may be the times ultimately adopted, the experiments already made render it improbable that the average time required by a light-house for repeating its number should amount to one minute.

It is by no means necessary that the counting of the number of a light-house should commence with the digit which expresses hundreds. No greater amount of time would have elapsed, if, in the above instance, the observer had commenced with counting the unit's figure. It would then have read thus: (three occultations;) long interval; (two occultations;) pause; (four occultations;) pause.

By the long interval denoting the commencement of a number, it is already apparent that the number of the light-house is 243, and not 324.

In order still further to prevent mistakes arising from an incidental error in counting the number of occultations, it will be convenient to establish another principle for the purpose of numbering the light-houses.

Light-houses must not be numbered in the order of their position; but every light-house must have such a number assigned to it, that no digit occurring in the number denoting the several light-houses nearest to it on either side shall have the same digit in the same places of figures.

If five adjacent light-houses were thus numbered:

361, 517, 243, 876, 182:

supposing a mistake to have occurred in the first time of counting 243, and that it had been reported to the master of the vessel as 253, he would immediately, on looking at his numerical list of light-houses, perceive that a mistake had been made in the middle figure; because, in any general arrangement, 253 would have been assigned to some light-house on a coast very distant from that on which 243 was placed. In fact, two out of any three figures would always detect the error of the third.

The occultations would distinguish every light-house from all casual lights, and their number would identify the light. The whole illuminating power would be always employed, undiminished by the interposition of colored glass. These lights would be more readily visible at a distance, because it is known that the eye perceives more readily a faint light which is intermittent, than an equal light which is fixed.

The board regard this as the most important proposition for distinguishing lights which has ever been made, and propose to make full experimental trials of it.

In fogs, Mr. Babbage proposes to make the pauses between the strokes of the gong take the places of the occultations of the light.

To give this great plan a full development, all nations should unite in a

system of numbering for light-houses. Such a co-operation might reasonably be looked for, if the plan have all the success which is now expected.

The entire communication of Mr. Babbage to the board will be found in the appendix BB.

BEST MODE OF ASCERTAINING THE NECESSITY FOR INTRODUCING NEW LIGHTS, BEACONS, &c.

Legislation is, of course, necessary to the establishment of a new light. The recommendations of the light-house board, of officers of the coast survey, of pilots, navigators, and others, all reach the Committees of Commerce of the two houses of Congress, through different appropriate channels.

It does not seem practicable to propose any system of examination of sites which would not be very expensive, while legislation is pending on the subject. A reference to the light-house board, in doubtful cases, would secure the committees from recommending appropriations for objects which certainly would not have the approval of professional men.

The law of the last session provided for the examination of sites, for which appropriations were made, (*vide* appendix,) by the officers of the coast survey, and a report by the superintendent. As this will leave a full knowledge of all the circumstances of the case, and be attended with very little expense, the board recommend that the same plan be pursued in all future cases.

BEST MODE OF SUPPLYING NEW LIGHTS.

When it has been shown, to the satisfaction of Congress, that new lights are required, and appropriations made for the purpose, the plans and specifications for construction, illuminating apparatus, distinction, &c., should be made by the engineer of the light-house board.

Should a previous estimate have been made by this engineer, for the information of Congress, generally, there will be required but little more than to fill up the details.

The construction having been approved by the light-house board, a contract should be entered into, according to law—based entirely upon the plans, drawings, and specifications and estimates of the engineer—and the building should be erected, and the lighting apparatus and accessories be procured, under the inspection of the engineer of the board, or of such officer of the corps of engineers of the army as may be detailed for the purpose, in conformity to the 9th section of the act approved 3d March, 1851.

All the details should be subject to similar inspection.

MODE OF RENOVATING LIGHTS.

Whenever the light-house board is satisfied of the necessity for renovating any existing light, by the introduction of better illuminating apparatus, &c., the engineer of the board should be required to prepare estimates and plans in detail, to be submitted to the board, which should be passed upon, and, if approved, the necessary steps should be taken to make the repairs, &c., according to law; or in the event of the expense being too great to admit of the works being done, except by a special appropriation, then the necessary estimates, explanations, &c., should be prepared and sub-

mitted, through the Secretary of the Treasury, for the consideration of Congress.

It should also be the duty of the board to procure all the necessary information relating to the establishment of new lights, abolishment of old ones, &c.; to be accompanied by estimates of cost, to be submitted, through the Secretary of the Treasury, to Congress, at the commencement of each session.

DISCONTINUANCE OF UNNECESSARY LIGHTS.

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The substantial agreement of all the reports, as to the qualities of the oil, renders it needless to enter into any details as to the slightly varying circumstances of each case; and I have, therefore, great satisfaction in briefly stating, as follows, the very favorable conclusions at which I have arrived:

“1. The colza oil possesses the advantage of remaining fluid at tempera-

tures which thicken the spermaceti oil, so that it requires the application of the frost-lamp.

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"3. The colza oil burns, both in the Fresnel lamp and the single Argand burner, with a thick wick, during seventeen hours, without requiring any coaling of the wick or any adjustment of the damper, and the flame seems to be more steady and free from flickering than that from spermaceti oil.

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That efficient lights along the coasts of all maritime countries are essential to a safe navigation, and the successful prosecution of a lucrative commerce, will not be contested; that all mere personal or local interests should give way to the general good, is an assumption which will not meet with disfavor in this country; and inasmuch as it is of paramount importance to the best interests of the whole country, that our lights and other aids to navigation should be the best which money, science, and the mechanic arts will afford, it is, in the opinion of the board, the duty of those charged with this important branch of the public service to employ every reasonable means, not inconsistent with law, to perfect them, and therefore recommend that the subject of introducing other combustibles than the oil now used be taken into serious consideration, as one of the means of improving our lights, and, at the same time, of effecting considerable annual saving of expense to the country.

If the rape-seed were cultivated to any extent in this country, it is not doubted it would supply the place of the numerous chemical oils, fluids, &c., now in general use for domestic purposes, as well as for lighting our light-houses and light-vessels. To insure the consummation of so desirable an object as the cultivation of this plant on a large scale in this country, where climate and soil are so well adapted to it, will be to place it in a fair competition with its rivals.

It will be the duty of the board, if authorized by Congress, among its numerous other important duties connected with the light-house establishment, to examine into the merits of all proposed improvements in apparatus and combustibles, and, by their recommendations to Congress, keep pace with the improvements of other countries in this branch.

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The material is iron or wood, sometimes covered with sheet-copper.

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numbers should be placed above the buoys, on stems or perches; should present the same appearance on different sides, and have their distinctions by difference in a vertical line, and not by varying horizontally.

Several plans have occurred to them. Three solids, the cone, cylinder, and sphere, arranged in groups of not more than three each, will give forty-two combinations; no one of these figures can be taken for the other, and they may easily be placed on stems projecting nearly vertically above the buoy, the several solids being placed one above the other, with a sufficient interval. They can be of adequate size, and may be cheaply made in the turning-lathe.

The elementary forms of the unit, the five and the ten, of the Roman numerals, are the cylinder, the cone and the double cone. By combinations of these, thirty-nine numbers are represented. Seven numbers may be represented by two signs and their combinations; twenty-eight by three signs, restricting the number of elements in any one combination, to four.

Seven numbers of every ten may be represented by only two more signs than those expressing the value of the ten's place, giving a very great variety.

A letter made to revolve about a vertical axis, produces a solid of revolution which is easily recognised as the sign for the letter. Fourteen of the twenty-six letters are adapted to characteristic signs, as shown in the accompanying figures (A, B, E, I, J, L, O, P, Q, R, T, W, V, Y.) Nine digits of the Arabic numerals, viz: 1, 2, 4, 5, 6, 7, 8, 9, and 0, give easily formed and easily recognised signs, as is shown in the accompanying plate; and these the board recommend for numbering buoys, excluding 3 as not sufficiently characteristic.

In the English system of placing buoys, a red and black are placed on opposite sides of a channel, and the vessel runs between them. In our system only one buoy is placed on the starboard or port hand, and the vessel runs for the buoy, keeping it close aboard in passing. The English system is most simple, and even the most economical. In order to render buoys available at night, various propositions have been made for causing them to appear luminous, but none have succeeded practically. Mr. Babbage proposes a gas-light, which might be produced by easily decomposable materials, or from compressed gas, which, when once lighted, would burn for a considerable time. If a pile were substituted for a buoy, it might be practicable to cause a prism, placed on it, to show by reflected or refracted light; the rise and fall of the tide keeping the prism in constant revolution, and the light being directed upon it from the shore. In many cases, a single screw-pile may be necessary, as for mooring purposes, being substituted for a floating buoy.

The board propose at an early day to enter upon the series of experiments authorized by the department to be made, a report upon which, and upon other matters not fully reported upon at this time, embraced in your instructions, shall also be made in time to be laid before the present session of Congress.

The board having thus endeavored to place before the department and Congress the present condition of the light-house establishment, which has existed since 1789, without that fostering care from legislation which its great importance demands, and with the view of remedying, as far as they can be, the defects now existing in all its branches; having recommended the organization of a light-house board, subject to the superintendence and

direction of the Secretary of the Treasury, which shall be composed of persons of ability, whose professions and vocations best adapt them to these duties; and following the example of the best light-house establishments in the world, recommend that these duties shall be performed without additional compensation.

The board are clearly of the opinion that the present light-house establishment can only be improved and rendered as efficient as the interests of the country demand, by changing its present character, in so far as to place it in the hands of such eminent professional men as they have proposed.

The board cannot close this report without acknowledging, through you, sir, their great obligations to Charles Babbage, esq., of London, for his valuable communication to them, through one of their members, disclosing his plan of distinguishing lights by occultations, &c., &c., (vide appendix;) to M. Léonor Fresnel, officier de la legion d'honneur, inspecteur divisionnaire des ponts et chaussées, &c., &c., Paris; M. L. Reynaud, ingénieur en chef des ponts et chaussées, secrétaire de la commission des phares, &c., &c., Paris; Mr. Jacob Herbert, secretary to the Trinity House board, London; Mr. William Lord, marine surveyor to the port of Liverpool, &c., &c.; Mr. Stevenson, civil engineer, Edinburgh; M. Henry Lepaute, of Paris, constructor of lenses; M. Theodore Letourneau, constructor of lenses, Paris; and Mr. Alexander Mitchell, of Belfast, Ireland—for their valuable communications, accompanying documents and drawings; and also to the numerous individuals in this country interested in commerce and navigation, who have kindly furnished replies to their letters asking for information upon the subject of light-house comparisons or improvements. (Vide letters, &c., &c., appendix.)

The board are under additional obligations to M. Reynaud, the distinguished engineer, secretary to the commission des phares, of France, for numerous beautiful specimens of glass chimneys and wicks for light-house lamps, and for drawings of value connected with the service.

The board would further avail themselves of this occasion to tender their thanks to the Hon. William C. Rives, Envoy Extraordinary and Minister Plenipotentiary to France, and to the Hon. Abbott Lawrence, Envoy Extraordinary and Minister Plenipotentiary to the Court of St. James, for their kindness in becoming the medium of communication between the board and the light-house authorities of those countries.

All of which is respectfully submitted.

W. BRANFORD SHUBRICK,
President.

JOS. G. TOTTEN,
Brevet Brigadier General.

JAMES KEARNEY,
Lieutenant Colonel Topographical Engineers.

S. F. DUPONT,
Commander U. S. Navy.

A. D. BACHE.

THORNTON A. JENKINS,
Lieutenant U. S. Navy, Secretary to Light-house Board.

To Hon. THOMAS CORWIN,
Secretary of the Treasury.

APPENDIX.

APPENDIX AA.

OFFICE OF LIGHT-HOUSE BOARD,
January 6, 1852.

SIR: By direction of the light-house board, I have the honor to communicate certain resolutions adopted by it, in relation to illumination of light-houses.

These resolutions were adopted unanimously, and are the result of information gathered from various sources and embodied in a report now in preparation, and which will very shortly be submitted; they are submitted in advance of the report, that the department may be at the earliest moment in possession of the views of the board on the subject of the 7th and 9th sections of the act of Congress of 3d March, 1851.

I am, very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,
President Light-house Board.

Hon. THOMAS CORWIN,
Secretary of the Treasury.

At a full meeting of the light-house board, holden on the 6th of January, 1852, the following resolutions were offered and unanimously adopted:

Resolved, That it is the opinion of this board—

1. That the lens or Fresnel system of light-house illumination is the best at present known.

2. That the lens or Fresnel system of light-house illumination is, in economy, brilliancy, power and usefulness, superior to the best reflector system of illumination in the ratio of about 4 to 1; or, in other words, that the lens system is about four times more advantageous than the best reflector system, and at the same time, at an expense, for oil alone, of only one-fourth as much as the reflector system.

3. That the lens system of light-house illumination is as well adapted to the coasts of the United States as to those of the rest of the maritime world.

4. That while there is no well-founded objection to introducing the lens system of illumination into this country, there is every reason for doing so as rapidly as possible.

5. That the floating lights of this country are comparatively useless to the mariner, in consequence of the very inferior apparatus employed in them.

6. That the reflector lights of the United States are greatly inferior, in usefulness, power and range, to the same description of lights in foreign countries generally, but especially to those of Great Britain.

Resolved, therefore, That this board, in obedience to the instructions of the Treasury Department, respectfully recommend to the Hon. Secretary to

direct the introduction of the Fresnel lens apparatus into all new lights that are now or that may be hereafter authorized to be erected, and also into all lights requiring new illuminating apparatus, in conformity to the 7th section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851.

Resolved, That this board further respectfully recommend that the Hon. Secretary of the Treasury direct that all floating lights now authorized and all that may be hereafter authorized, and also all requiring new illuminating apparatus, may be fitted with the best system of reflectors and lamps, or Fresnel lenses, and that the best reflectors which may be taken from light-houses requiring new apparatus shall be placed in floating lights, with reference to the importance of the light and condition of the reflectors and lamps.

Resolved, That this board respectfully recommend that all works relating to new structures, alterations of buildings and all extensive repairs of towers and buildings belonging to the light-house establishment, be placed under the charge of an engineer of the army, upon whose plans and estimates, when approved by the proper authority, the contracts shall be made, and under whose superintendence the work shall be executed, in conformity to the ninth section of the act making appropriations for light-houses, light-boats, buoys, &c., approved March 3, 1851.

Resolved, That the president of the board address a letter to the Hon. Secretary of the Treasury, communicating the foregoing resolutions.

WM. B. SHUBRICK,

President Light-house Board.

A true copy :

THORNTON A. JENKINS,

Secretary to Light-house Board.

APPENDIX BB.

PLAN FOR DISTINGUISHING SEA-COAST AND OTHER LIGHTS BY OCCULTATIONS.

BY CHARLES BABBAGE, ESQ., &C., LONDON.

Resolution of thanks to Charles Babbage, Esq.

Resolved, That the light-house board of the United States have received with much gratification, and have examined with great interest, the plan of distinguishing sea-coast and other lights by occultations, proposed by Charles Babbage, esq., of London, and kindly communicated to them, and will use every endeavor to have a full trial made of the method, which in their opinion promises such great advantages to the navigation of the world.

Resolved, That the thanks of the board are hereby tendered to Charles Babbage, esq., for his communication made on the invitation of one of its members.

Adopted unanimously, November 26, 1851.

WM. BRANFORD SHUBRICK, *President.*

THORNTON A. JENKINS, *Secretary.*

NOTES RESPECTING LIGHT-HOUSES.

BY CHARLES BABPAGE, ESQ.

The object of these notes is to point out certain improvements in the use of existing light-houses, by which it shall become almost impossible—

- 1st, To mistake any casual light, on shore or at sea, for a light-house ;
- 2d, Ever to mistake *one* light-house for another.

The plan requires, in most instances, no change in the optical means at present used for condensing and directing the illumination of light-houses ; it adds slightly to the facility of observing them at great distances, and from its simplicity and generality is equally adapted to the use of all countries. Revolving-lights must become fixed ; but the mechanism already existing for their rotation may, with little alteration, be employed for the motions required by the new system.

The principle by which these objects are to be accomplished, is to—

Make each light-house repeat its own number continually during the whole time it is lighted.

This is accomplished by enclosing the upper part of the glass cylinder of the Argand burner by a thin tube of tin or brass, which, when made to descend slowly before the flame, and then allowed suddenly to start back, will cause an occultation and re-appearance of the light.

The number belonging to a light-house may be thus indicated to distant vessels. Take as an example 243.

1. Let there be *two* occultations.
2. A short pause.
3. *Four* occultations.
4. A short pause.
5. *Three* occultations.
6. A longer interval of time.

This system of occultations must be repeated all night by proper mechanism.

The rapidity of the occultations themselves, the length of the pauses between the units and the tens, and between the tens and the hundreds, as well as the duration of the long interval of time which marks the termination of the number, must be made the subject of experiment.

A light has been already used as an illustration, in which the occultations occurred at intervals of one second ; the pause occupied four, and the long interval ten seconds. The pause was thought to be unnecessarily long, and was diminished. Whatever may be the times ultimately adopted, the experiments already made render it improbable that the average time required by a light-house for repeating its number should amount to one minute.

It is by no means necessary that the counting of the number of a light-house should commence with the digit which expresses hundreds. No greater amount of time would have elapsed, if, in the above instance, the observer had commenced with counting the unit's figure. It would then have read thus :

(3 occultations,) long interval, (2 occultations,) pause, (4 occultations,) pause.

But, since the long interval denotes the commencement of a number, it is already apparent that the number of the light-house is 243, and not 324.

In order still further to prevent mistakes arising from an accidental error in counting the number of occultations, it will be convenient to establish another principle for the purpose of numbering the light-houses.

Light-houses must not be numbered in the order of their position. But every light-house must have such a number assigned to it, that no digit occurring in the number denoting the several light-houses nearest to it on either side shall have the same digit in the same place of figures.

If five adjacent light-houses were thus numbered: 361, 517, 243, 876 and 182, supposing a mistake to have occurred in the first time of counting 243, and that it had been reported to the master of the vessel as 253, he would immediately, on looking at his numerical list of light-houses, perceive that a mistake had been made in the middle figure, because in any general arrangement, the number 253 would have been assigned to some light-house on a coast very distant from that on which 243 was placed. In fact, two out of any three figures would always detect the error of the third.

The law of numbering just stated is sufficient for the present object. Probably a little inquiry might produce a still better arrangement.

Thus occultations would distinguish every light-house from all casual lights, and their number would identify the light itself. The whole illuminating power would be always employed, undiminished by the interposition of colored glass. These lights would be more easily visible at a distance, because it is known that the eye perceives more readily a faint light which is intermittent than an equal light which is continuous.

OF HARBOR LIGHTS.

The same principle of numerical lights is equally applicable to light-houses which indicate harbors. Information, however, of another kind, is often requisite for vessels about to enter them. It is always desirable that the depth of water, either within the harbor or on the bar, should be known.

This may be effected most simply by allowing the occultations of white light to indicate the number of the light-house, and instead of having a *long interval* of white light between each repetition, let a colored glass be placed before the light, and a number of occultations be made, equal to the number of feet of water existing at the time.

Thus a tidal-harbor light-house will continually repeat its own proper number in white light, followed by the number of feet of water on the bar in colored light. If it should be thought desirable, it would be easy to make the color of the light *blue* when the tide is rising, and green when it is falling.

The mechanism for harbor lights need not be complicated, and by means of a float might be made entirely self-acting. The weight necessary for making the occultations might even be wound up by the float itself.

Another great advantage of a float is, that the depth of water indicated will always be the real depth at the time. The computed depth often differs from the true depth, owing to the influence of storms, and other accidental causes.

Some additions to this mechanism would enable it to indicate the depth of water on the bar by day as well as by night.

OF FOG SIGNALS.

During the prevalence of fogs, the lights which ought to guide the seaman are often indistinctly seen, or entirely obscured, until he has approached too near the danger against which they were intended to warn him.

In cases of fog, light-ships and light-houses are in some instances provided with gongs and bells, which are then kept constantly sounding. It is unfortunate that the means of warning the seaman of his danger should extend to the shortest distance when that danger is most imminent. The lights usually employed are visible at a distance of from six to thirty miles; but the sound of a gong or bell is heard at a comparatively very small distance.

When these instruments are heard they merely indicate danger, but not its exact nature. It might in some cases be of great importance that the gong or bell should indicate the number of the light-ship. This could be accomplished by a very trifling alteration in the mechanism. Instead of striking the instrument at fixed intervals, let there be pauses and a long interval between the number of strokes which successively represent the digits of the number of the light-ship, just in the same manner as has been proposed for light-houses.

A light-house or light-ship whose number is 243, would be thus indicated during fogs:

(2 blows on gong,) pause, (4 blows on gong,) pause, (3 blows on gong,) long interval.

The same mechanism which caused the occultations of the light, might produce the blows on the gong.

The preceding explanations are sufficient to show that each light-house or light-ship, by continually repeating its *own number*, might render any mistake of it for a different light very nearly impossible. The great principle on which the system rests, is *to give numerical expression to each light*. If it be not thought necessary to apply it to every light-house, the most important may be chosen for its application. The expense of the alteration, and the amount of danger incurred by a mistake, will furnish the ground of decision in each individual case.

In proposing, however, a new system which has extensive bearings on other questions connected with the safety of those who travel on the waters, it is desirable that a general and comprehensive view should be taken of such of its applications as the rapid advance in mechanical and chemical science justify us in supposing must take place in a few years.

However partially the system may be adopted at first, a judicious foresight into its probable applications may enable us, without any present inconvenience, to accelerate future improvements, and to save considerable expense on their adoption.

The following suggestions for improvements or applications, many of which are perfectly practicable at the present time, are offered for the consideration of those who may be called upon to carry out the *Numerical System of Light-houses*. They are not necessary for the success of the simple plan which has been already described, but may be adopted or rejected without any interference with it.

SUGGESTIONS FOR THE IMPROVEMENT OF LIGHT-HOUSE SIGNALS, BUOYS, &c.

Telegraphic communication during the night between light-houses and ships in distress.

Cases occur in which it is of great consequence that a ship should communicate with the land long before it can send a boat ashore, or enter its intended port. It may be the bearer of important intelligence. It may convey some personage whose presence is essential for some great object. The vessel itself may be in distress. The state of the elements may render it impossible to send for, or receive, any assistance from the land; yet, even under such unfavorable circumstances, if directions from skilful pilots acquainted with the coast could be conveyed to the ship, its wreck might, perhaps, be prevented; or, if driven on shore, having been directed to the least unfavorable spot, its crew might possibly be saved.

Such communications might easily be organized. There are already existing in the Royal Navy in the East India Company's service, and elsewhere, large dictionaries of numerical signals. These, it is true, are made by flags, or by balls; but the same numbers may be expressed by the occultations of lamps. Any number, however large, may be expressed by making the number of occultations corresponding to the first or highest digit, then allowing a pause; after which the number of occultations representing the second digit, then a pause; and so on, always observing that, after the unit's figure has been expressed, there must follow a long interval.

The plan for telegraphic communication would be thus arranged:

1. Light-house repeating its own number.
2. Ship fires a gun, and hoists a light, to call the attention of the light-keeper.
3. Light-house ceases repeating its number, and becomes a steady light, thus informing the ship that it is observed.
4. Ship having prepared its message, numerically expresses it by the occultations of its own lamp.
5. Light-house repeats the message of ship, in order to show that it has been rightly understood.
6. Light-house now repeats its *own number*, whilst it is preparing the answer.
7. Light-house expresses its answer by occultations.
8. Ship repeats the answer.

This interchange of question and answer is continued as long as necessary, during which the light-house repeats its own number previously to each reply.

Very little delay will occur: for these questions and answers will be arranged on movable disks, which may be placed in the mechanism employed for occulting, even whilst it is repeating another message. Many such disks, each containing a different message, may be placed in the machine at once, and on touching any lever the light will continue repeating the corresponding message.

In case of a ship in distress, for instance, requiring an anchor of given weight, it may be necessary to send to the harbor-master of the adjacent port to give the order, and to ascertain the time when it can reach the

vessel. During this interval, the light-house will be repeating its own number.

An electric telegraph from the light-house to the dwelling of the harbor-master would save much time, and in some cases much damage.

The gun fired by the vessel might also be heard by the harbor-master, and his attention then being directed to the telegraph light-house, the whole time might be saved. If even his own house was invisible to the ship, but within view of the light-house, he might by means of a small light correspond with the ship through the intervention of the light-house, repeating the signals of both parties.

Colored shades might, if thought expedient, be used for different dictionaries; or an entirely independent lanthorn might be specially devoted to signals; but this would cause additional expense, and seems unnecessary.

It may be objected to this plan, that it would mislead other vessels on first coming in sight of the light-house. This objection, however, will be found on examination to be invalid; for a ship on first getting sight of a light-house, will be at the distance of many miles; and as all telegraphic messages would consist of more than three places of figures, the ship would immediately perceive that the light-house was acting telegraphically, and on turning to the dictionary, would even become acquainted with its message. Besides, in the course of every three minutes, at least, the light-house would repeat its own number. Thus the ship would always know that it was in the presence of a light-house; and if its reckoning did not enable it to identify the light, it could only remain in doubt during a few minutes.

Telegraphic signals between ships at night.

The application of the system of occultations to ships at sea, may not, perhaps, be quite so easy as that which is proposed for light-houses, but no objections have yet occurred which appear at all insurmountable.

The question of the position of the occulted light or lights placed on the ship, must be settled by practical men after due consideration and experiment. It may, however, be suggested that a light hid by a mast or sail may yet have its occultations made perfectly apparent by reflection from another sail. If such a system of signals were adopted, fleets might sail in company during the night, each repeating its own number, and any orders could be conveyed to any individual ship.

Specific lights have already been employed to distinguish sailing-vessels from steamers, in order to prevent collision. By adapting the system of occultations to one or more of the lights of steamers, their character would appear more distinctly, and at greater distances. Perhaps, indeed, it would be better to have the distinctive character of a steam-vessel indicated by a continual enlargement and diminution of its light, rather than by an occultation. Two steamers also would have much less reason for approaching each other, because they could hold any correspondence by signals. They might also by the same means convey to each other their intended course long before they approach each other.

Of a universal dictionary of signals.

Whether the system of occultations be generally adopted or not, numerical dictionaries of signals have been found absolutely necessary, and have

long been in use. The rapid increase, both of ships and of steamers, renders some common language for all nations almost a matter of necessity.

The concurrence between adjacent nations in numbering their respective light-houses, would be essential if any *numerical system* is adopted for distinguishing them. Such an opportunity ought not to be lost of rendering those discussions still more useful by attempting to organize a plan for a universal system of numerical signals. The first step might, perhaps, be that each nation should supply all questions and answers that ships could ever require for their safety or convenience. Out of these, the duplicates being omitted, the first draught of the naval part of the dictionary might be formed. This being submitted to criticism, would probably itself suggest many additions.

The questions should be very carefully translated into the languages of all maritime nations, and should be printed in columns for each language.

A dictionary of this kind, containing about five thousand terms in ten European languages, was published in 1849, by M. K. P. Ter Reehorst. The words are contained on about two hundred double pages; and since each word, of which there are usually about twenty-five in a page, is numbered, this work might be used as a numerical telegraphic dictionary.

If a more general dictionary were undertaken, other considerations arise, and the great questions relating to the philosophy of language must be examined with reference to such a work. It will, however, be sufficiently early to enter on that subject when any steps are seriously taken to accomplish so desirable an object.

The continually increasing use of the electric telegraph renders a universal language still more desirable.

ON THE IDENTIFICATION OF A LIGHT-HOUSE.

A case has been more than once suggested to the author, to which it may be desirable to advert, in order to point out the course of experiment which may lead to its removal.

At certain periods of the year, and on certain coasts, there occur dense fogs. Under these circumstances, it has happened that a vessel has, on a partial and momentary opening in the fog, insufficient to show more than a single occultation, found herself almost close upon a light-house. In such a case, there is neither time nor opportunity to ascertain its number.

It may here be remarked, that the assumed danger of going ashore is so imminent, that it is not *necessary* to know the number. It is sufficient for the moment to know that there is a light-house in a certain direction, which is close at hand.

It must, however, be admitted, that in common with all received systems of lights, the method of occultations will not furnish a remedy. If a colored light is already employed in particular localities, to meet such a case, it will still accomplish the purpose when occultations are applied to it.

The danger, although rare, ought, however, to be provided against. The following remarks are suggested to assist in attaining that object:

The time between two occultations (usually one second) might be doubled in special cases. A little experience would enable most men to recognise the fact after two occultations. If such light-houses were placed alternately with others, no light-house would be mistaken for either of its

adjacent neighbors. This plan might be partially extended, but it is liable to objections.

Another view may be taken. Is it possible to give a specific character to the occultation itself? It has been found, that if the occulting cylinder descend rather slowly over the lamp, and then, after a *very short* pause, rise suddenly, the effect is best. It has also been observed, when an accidental defect in the apparatus caused the cylinder, after suddenly rising up, to rebound, and again to obscure partially the lamp, that the nature of the occultation was peculiarly characteristic. This peculiarity was very remarkable up to a certain distance, after which it became lost. Almost any form of peculiarity can be given to the occultations by giving proper forms to the cams which govern them. The fact that such peculiarities are not seen until the ship has approached within certain distances, does not appear to present a material difficulty, and may even prove an advantage.

It would seem, then, to be desirable to institute a series of experiments to determine the following questions: Can the occultations of a lamp, in which the rapid re-appearance of the light occurs from the falling *down* of the shade, be distinguished from those in which it occurs in consequence of the rapid *rising up* of the shade; and if so, at what distance? In some cases, the shades might move from right to left, and in the reverse direction. What peculiarities in occultations can be seen at the greatest distances?

Amongst the experiments still required, may be mentioned the loss of light resulting from the interposition of colored glasses, and also the proportion of light lost by sacrificing *given* portions of various parts of the optical apparatus used for concentrating it. This is necessary, in order to enable us to judge what portion may be most economically sacrificed, in case the space might be required for other purposes.

The dangers arising from fogs are of such an extent, that all the resources of science ought to be called in to remove them.

Voltaic light can scarcely be depended upon, except under continual superintendence; it would therefore be expensive. If, however, any intense light can be found capable of penetrating dense fogs, it might, during their continuance, be good economy to employ it even at considerable expense.

Perhaps the ordinary light-house lamps might be supplied with *oxygen* during fogs; its expenditure being regulated by the obscurity to be penetrated.

Possibly, portions of phosphorus might be burnt in oxygen, and the light-house would then express its number by a series of *flashes*, and of *pauses* between them. The new form which that body is now known to assume, might render its application to this purpose free from danger.

ON SOUNDS USED FOR SIGNALS.

Both gongs and bells are employed as substitutes for lights during fogs. I am not aware of any series of experiments on the distances at which sounds of various kinds can be heard. In a question on which so much property and so many lives depend, it is surely important to be well informed. The only resource is experiment. It may be remarked that the low notes of the gong might be confounded with those of the roll of waves breaking on the shore, whilst the shrill whistle of the steam-engine will find a rival in the wind whistling through the rigging. The trumpet and the

new and still more powerful instrument at the recent exposition ought also to be compared.

Again, although some of these may be heard at greater distances in the open air, some may be more easily adapted to have their sound concentrated and directed, when placed in the focus of a parabolic mirror, or, perhaps, at the end of a long tube.

Sound is transmitted to considerable distances through water, and it has been suggested that this might be used in case of fogs. But it seems probable that sound would be much interrupted in its progress, from the constant motion of the waves; and if it were transmitted at a considerable depth, it might be difficult for a vessel to send down an apparatus to render it sensible.

Experiments should be made on the distance at which sounds can be heard under water in various circumstances of its motion.

If, during storms, the surface only is agitated, it might be possible to transmit sounds in the still water near the bottom to considerable distances. Thus channels might be traversed by telegraphic communications with a less costly apparatus than that of the electric wire. It ought also to be ascertained whether the forms of the instruments struck would enable them to project their sounds in particular directions. Gongs, bells, and the firing of cannon under water, are among the sounds to be tried.

Whatever may be the sound audible at the greatest distance, it will be necessary to ascertain what are the best means of producing it in greatest intensity—whether by one large instrument, or by many small ones. It seems probable that some combination of discordant sounds may be most effective, because it seems to be a law of our nature that contrasts produce stronger impressions than uniformity. There is one form of sound the most disagreeable with which we are acquainted; it is said “to set the teeth on edge.” What is the cause of this, and does that highly obnoxious sound penetrate farther than others? If it penetrate as far as others, it will certainly be the earliest to be noticed.

LIGHTS ON BUOYS.

The time is probably not remote when lights will be placed on floating buoys, for the purpose of pointing out isolated dangers—as sunken rocks, shoals, &c., on which light-houses cannot be placed, or where the great expense may prevent them from being built. They may also be useful to indicate the channels leading to some few ports of very great resort, in order to render the approach of vessels possible during the night.

The first difficulty in placing lights on buoys arises from the necessity of trimming the lamps, and of supplying them with fresh oil. Galvanic processes seem to present a similar difficulty. The chemical discoveries of recent times, however, offer some hope of removing it. By the destructive distillation of peat, of coal, and of shale, as well as by other methods, a variety of combinations of hydrogen and carbon have been obtained. Some of these only remain liquid under a pressure of two or three atmospheres. They possess considerable illuminating power; and by confining them in a close vessel, and allowing a very small aperture for their escape in the state of gas, a jet of flame may be produced, of uniform magnitude, and without the use of a wick, until the last drop of fluid has evaporated. If such a fluid could be produced at a moderate price, a quantity might be enclosed within the buoy, sufficient to last several weeks, if not months.

Such a light would burn without the necessity of trimming, but it would require mechanism to light it each evening, and to put it out each morning.

Such mechanism already exists in many of our public clocks. If it is thought desirable, too, that it should occult, so as to indicate its number, the plan already described might be applied. Thus the buoy would contain two pieces of mechanism. The only remaining difficulty would be the necessity of visiting the light frequently in order to wind up the two instruments. This might probably be removed by having within the buoy a heavy pendulum, or perhaps two such, swinging at right-angles to each other. If the *perpendicular* motion of the buoy could be secured, then the winding up pendulums must be maintained horizontally by means of a powerful spring. These, by the action of the waves, would be continually winding up the springs which drive the mechanisms. This might be so arranged that it would never over-wind them.

Spirits of turpentine, benzole, and several other compounds, assume a gaseous state at very low temperatures. If the end of a tolerably thick rod of metal is heated by the flame of the lamp, and the other end conducts the heat to the bottom of the fluid, it is sufficient to produce a continuous stream of gas to supply the burner until the last drop of the fluid is exhausted. Lamps constructed on this principle have, under various names, been in use for several years. If the fluid were sufficiently cheap, one of these movements might be dispensed with, by allowing the light to burn constantly during the day as well as the night.

New forms would be required for such buoys. Probably a columnar form, weighted at the bottom, might give a steadier light amid the fluctuations caused by the waves. These buoys should be attached to their moorings by rings fixed at the centre of resistance.

OF THE MECHANISM NECESSARY FOR OCCULTING LIGHTS.

The period of time occupied by any occulting light in making a signal is so short, that great accuracy in the wheel-work is not necessary. In light-houses the moving power may be a heavy weight driving a train of wheels. This must terminate in a governor, which presses by springs against the inner side of a hollow cylinder.

When the length of the time necessary to indicate the number of the light-house is known, the governor must be so adjusted, that some one axis shall revolve in the given time. A cam-wheel must be fixed on this axis, having its cams and blank spaces so arranged as to lift up the tail of a lever carrying the occulting cylinder, at the proper intervals of time. Each tooth of the cam-wheel will cause an occultation of the lamp by the cylinder, which is instantly drawn back by a spring.

It is obvious that an axis might be used which moves round in the course of two, three, or more cycles. In this case, the same system of cams would be repeated an equal number of times in the circumference of the cam-wheel. This plan is sufficient for light-houses which are not intended for signal stations also.

When signals are to be used, it is better to have a single cam on an axis which revolves once in the time which elapses from the end of one occultation to the end of the next. The effect of this cam will be, by acting upon a forked lever, to lift up the occulting cylinder. If nothing retain it in that position, the action of the spring on the lever will cause it to descend, and

the cylinder, acted on by gravity, will instantly follow. But if an arm is interposed which retains the cylinder, then the forked lever alone will be pulled back by its spring, and the occulting cylinder will remain suspended until the next turn of the cam-wheel.

The suspending arm which was interposed must itself be governed by a cam-wheel, expressing the number of the light-house.

When a signal is to be made, an adjustable cam-wheel is to be set to the proposed signal, and is to be fixed upon the axis carrying the constant number of the light-house. When the proper time arrives for making the signal, it is only necessary to shift the axis, so that the adjustable cam-wheel shall be moved into the place occupied by the fixed cam-wheel. The signal will now be made and repeated as often as required, after which the original position of the constant cam-wheel must be restored. It is clear that any number of adjusting cam-wheels might be prepared for signals, and put upon the axis at once, so that a series of different signals might be made in a very short time.

Lights to mark the depth of water must have a heavy float connected with them, which at every foot of its rise or fall, must alter the number of occultations made by the colored light. It must, also, at the turn of the tide change the color of the light. It is sufficient for the present purpose to observe that the mechanism similar to that by which a clock strikes different hours, might be employed for this purpose.

The well in which the float is placed ought to be open to the tide by several small apertures ; this would render the rise or fall of the float more uniform.

Telescopes are used for observing light-houses. They have a small magnifying power, but a large aperture. It is important that they should be as short as possible, for taking in a given visual angle. Possibly, those constructed with a lens of rock-crystal might be employed with advantage, but upon this subject, also, experiment must be made.

APPENDIX A—No. 1 to 43.

QUERIES BY LIGHT-HOUSE BOARD TO AID IN INSPECTIONS, AND NOTES OF INSPECTIONS OF LIGHT-HOUSES, LIGHT-VESSELS, &c., 1851.

A—No. 1.

Queries to aid in inspections.

LOCALITY, DESCRIPTION, &c.

1. Name and locality of light ?
2. Coast, leading, harbor, or pier-head light ? Fixed, revolving, intermittent or colored ? &c., &c.
3. If a leading light, state what rocks, shoals, &c., it is intended to lead clear of, and the bearing and distance from them ?
4. If colored, how produced ; by the glass of the lantern, a colored shade, or a colored chimney ?
5. If a revolving light, state the time of the entire revolution of the ma-

chinery, and the number of sides or faces lighted, so as to give the number of appearances in a minute?

6. How often is the machine wound up?
7. Are the revolutions regular and without jerks? Is chain or rope used to suspend the weights?
8. Does the chain or rope break occasionally?
9. What substitute is there in the event of accident to the machinery?
10. How far necessary to be seen?
11. How much of the horizon illuminated?
12. Height above the level of the sea?
13. Height of tower from base to top?
14. One or more towers? one or more lights in one tower?
15. Reflector or refractor light? number of lamps and reflectors, or order of refractor?
16. When was the illuminating apparatus put up?
17. Reflectors spherical, or parabolic?
18. Diameter of burner?
19. Description of lamp?
20. Of what materials made, and whether or not the burners are tipped with silver to prevent too rapid decay?
21. How often do the burners require repairing?
22. What the present condition of lamps, burners, and reflectors or refractors?
23. How are the reflectors and lamps fitted to the frame? solidly, or not? are they easily put out of adjustment?
24. Are the frames (if a fixed light) permanently fixed, or are they left movable?
25. By whom are the lamps, reflectors, and other apparatus supplied, put up, and adjusted?
26. Have the lenses or reflectors been displaced or injured, and what means employed to remedy the evil?

LANTERN, &c.

27. Of what material is the lantern made?
28. Are the astragals vertical or diagonal? are they thick, or only of sufficient size to resist the elements?
29. What description and size of glass?
30. How is the glass put in?
31. How is the lantern ventilated?
32. Are the ventilators used, and how?
33. What means are at hand for replacing broken panes of glass at night?
34. Are there any storm-panes, fitted with screws and pads, ready to be used in case a pane should be broken at night?
35. Is the dome of the lantern painted white inside?
36. Are the sashes painted white inside?
37. Is the light now clean; clear of rags, broken chimneys, boxes, trimming and cleaning-materials, &c., &c.?
38. Is there sufficient room in the lantern for the apparatus, and for keeping it in order, and in attending upon it?

39. Are curtains hung up early in the morning when the lights are put out?

40. How often and by whom are the inspections of the apparatus made, with the view to cleanliness and proper repairs?

41. By whom are repairs and re-adjustments made to the illuminating apparatus?

42. Are the panes of glass of the lantern inside free from moisture or ice in all temperatures?

43. Are they single, or double?

44. Is the roof or dome double, with a space between the plates to check rapid condensation?

45. Are the panes of glass free from smoke and soot inside, when the lamps have been burning all night?

46. Do the chimneys become smoked during the night, or do they remain clear and bright?

47. Is there any, and what, mode of complete ventilation?

48. Are there any means at hand for keeping the panes of glass free from ice, sleet, or snow outside?

49. What extra lamps, reflectors, burners, &c., are kept on hand?

PERSONNEL.

50. Name and age of principal keeper?

51. When appointed?

52. What his business or vocation previous to becoming a light-keeper?

53. What training previous to taking charge of the light?

54. Does the principal keeper leave the light when he pleases, or by whose permission, and for how long a period can he be absent at one time?

55. Does he attend to any other business than the light duties?

56. What number of assistant keepers, by whom appointed, and by whom are changes made among the assistants?

57. Are reports made of changes, and to whom?

58. Do the principal and assistant keepers undergo any previous training or examination before entering upon their duties, and what are the requisite qualifications?

59. Do all the keepers live at the light?

60. Is a regular watch kept in the lantern or watch-room from lighting up until the lights are extinguished?

61. Does the principal keeper take a regular watch?

62. Is there any mode of summoning the keepers off watch by an alarm?

63. Does the principal keeper keep a journal of expenditures of oil and other supplies, of the weather, and of the public occurrences in the vicinity of the light?

64. Does the keeper make any periodical report of the condition of the light, consumption of stores, &c.; if so, how often, and to whom made?

65. Is any notice taken in the journal and reports of wrecks near the light, of the lights within the range, and not properly kept, and not lighted?

66. Are the lights visited to ascertain in what manner the keepers perform their duties; how often, by whom, and to whom are the results reported?

67. Does any professional person visit the light-house to superintend the repairs of the apparatus?
68. Do fogs prevail? Are fog signals established, and what kind?
69. At what distance is it supposed the fog signal can be heard?
70. Is there a barometer, thermometer, and clock attached to the building or tower?
71. What means of obtaining correct time?
72. Have wrecked seamen and others in distress been relieved at the light?
73. What means are there of affording relief in such cases; and are there any instructions for restoring drowned persons, at hand?
74. When are the lights lighted and extinguished?
75. How often and at what hours are the lamps trimmed?
76. How is it ascertained when to trim, in the case of a single keeper?
77. When are the reflectors cleaned and lamps and burners prepared for lighting?
78. What written or printed instructions have been furnished to guide the keeper in the performance of his duties?
79. How many copies are framed and hung up for reference in the tower and dwelling?
80. What detailed instructions have been furnished, relating to the manner of cleaning, trimming, and lighting lamps, &c., &c.?
81. Have any lights, within the range of this light, been reported as being out or badly kept?
82. What instructions in relation to lights in foggy or hazy weather?
83. Are any additional precautions taken at such times?

SUPPLIES.

84. How much oil is consumed per annum, quarter, and night?
85. How much winter and how much summer oil is delivered annually, by whom, and at what period or periods?
86. How often are the supplies delivered, and by whom?
87. Who decides as to the quantity and quality of oil and other supplies delivered?
88. Who repairs reflectors, lamps, &c.?
89. When bad or inferior oil, wicks, chimneys, &c., &c., are delivered, what steps are taken to obtain proper articles without delay?
90. How often, since the present occupant took charge, has the oil been bad; and what time elapsed before good oil was supplied?
91. Who determines, and what rule is followed, in ascertaining the proper quantities to be left of the two qualities used?
92. When is the use of the one or the other quality of oil commenced, and by whose direction or instructions?
93. What difference is there in the light produced by the two kinds of oil, when they are both considered good of their kind?
94. Does it require a greater quantity of the one or of the other kind of oil to keep up an equally brilliant light for a certain number of hours?
95. Are all the wicks made of the same material, and of the same closeness or openness?
96. Are all the glass chimneys equally good, referring to shape and quality of glass?

- 97. How many new lamps, burners, and reflectors are left per annum?
- 98. How long do the burners last without being repaired?
- 99. How many chimneys and wicks are consumed per annum?
- 100. Is the oil liable to congeal; if so, how remedied?
- 101. Is the oil kept in under-ground cellars or not, and what precautions are taken to insure as equable a temperature for the oil as possible?

TOWERS AND BUILDINGS.

- 102. What effect has the surf or sea upon the tower, glass of the lantern, and the light?
- 103. Does the spray ever fly over the light?
- 104. When last visited; how often visited per annum; by whom, and for what purpose; inspection with reference to condition and repairs?
- 105. Are there storerooms for wicks, chimneys, cleaning-powder, &c., and are they kept dry?
- 106. What the present condition of the tower and buildings?
- 107. Were they well built at first?
- 108. Do they leak, what causes it?
- 109. Are they damp or dry?
- 110. How is the foundation of the tower?
- 111. Is the drift-sand or sea encroaching upon the tower and other buildings, and what means have been employed to arrest their progress?
- 112. Has the tower ever been struck by lightning?
- 113. Is there an electrical conductor attached to the tower, and of what material composed; is it placed clear of large masses of metal, and led to good conducting matter?

IN ADDITION FOR LENS LIGHTS.

- 114. How many extra lamps are kept on hand?
- 115. How many ready filled and trimmed for use?
- 116. How long will it take to replace a lamp at night?
- 117. How often has the Carcel lamp of this tower gone out at night; how long a time elapsed before it was replaced and lighted?
- 118. What difficulties attend the management of the lens light?
- 119. What previous means of instruction were afforded to the present keeper before he took charge of the light?
- 120. Has the hydraulic or pneumatic lamp been tried in this light?

LIGHT-VESSELS.

- 121. Name of keeper?
- 122. When placed, by whom, and how moored?
- 123. Tonnage, age, height of lamp from water-line?
- 124. Description of lighting apparatus?
- 125. Amount and kind of oil consumed?
- 126. Description of wicks and number consumed per annum?
- 127. Number and rates of persons on board?
- 128. Pay and subsistence per month of each individual?
- 129. Is the light-vessel kept at her moorings during the entire year; if not, when removed; for what reasons; by whose orders; and when sent to her station?

130. How often has she broken from her moorings?
131. Is there a log or journal kept on board?—show it.
132. Instructions; how kept for reference?
133. Description of fog signal, and how far can it be heard under ordinary circumstances?
134. Spare anchors and cables?
135. Substitutes at hand in case of breaking from moorings?

BUOYS AND BEACONS.

136. Are the beacons kept painted and in good order?
137. What distinguishing marks or colors?
138. Are the buoys properly placed?
139. Are the buoys colored according to law?
140. Are the buoys of proper sizes and shapes?
141. How often removed for renovation?
142. Who places them, and how are the proper positions ascertained for placing them?
143. How moored; size and kind of sinkers and chains?
144. Do they subserve the purposes for which they are designed?

A—No. 2.

NAVESINK LIGHTS.

June 3, 1851.

James D. Hubbard, principal keeper. No vocation; was a farmer when made keeper; four assistants; only one of the four found there when he took charge, remains; the three others were dismissed by him without the authority or sanction of any one; no report made to the collector of the changes; took charge of the light August 28, 1849.

Tower of rubble stone; when built not known; present condition bad, in consequence of leaks, supposed to be owing to bad construction; a common black-lead pencil was run into the wall six inches; mortar exceedingly poor—lime gone entirely, leaving nothing but sand.

A copper-wire (French) conductor, *painted*, and placed very near heavy pieces of iron railing, &c.

Lights visited by Mr. Coggeshall about a month since, for inspection. The collector and Mr. C. visited them last fall.

No repairs or alterations made to towers for twenty months, and keeper does not know for how long a time before that; walls of tower cracked, and many leaks; three iron bands around the towers to sustain them; dwellings repaired within a year.

Repairs of revolving machinery made to a small extent last winter; stopped in consequence, as was supposed, of vibration of tower during a gale of wind.

Apparatus, first order fixed lens, and second order revolving lens; Lepaute, of Paris, constructor; lenses put in lantern in 1840; apparatus tolerably clean, but, for want of system, not properly cared for; mirrors broken, and in many cases out of adjustment; prisms injured in numerous places; repairs

to apparatus made by the keeper generally; no other means afforded for repairs; revolving machinery (clock-work) *got out of order*, and had to send for a *millwright*, and then for a watchmaker; did not succeed. There is no one who knows how to adjust the mirrors when out; *keeper does not think he can*.

Lanterns good; glass-plate; tolerably large; upper and lower panes jointed. There were three broken panes of glass in the lantern; glass put in by glazing-pins and slats. Interior of the dome of the lantern painted *red*; should be white, to prevent the absorption of light.

The establishment is clean; it has just been painted. Towers recently whitewashed outside; whitewashed ordinarily once in two years.

There are no oil-cellars; oil is kept on lower floor of the tower. There are no storerooms. Lanterns rather small; astragals horizontal.

Received May 30, 1850-----	1,252	gallons.
On hand May 27, 1851-----	316	"
Consumption per year, including that used in dwelling	936	"
Sperm oil (winter)-----	573	"
Whale oil (summer)-----	347	"
Oil condemned and sent away-----	332	"

The keeper keeps no daily account of expenditure, or journal of any kind. Supplied once a year with oil, and occasionally twice with other articles. When short of supplies, applies to New York; can get an answer in twenty-four hours. Bad oil when he took possession; returned it to Howland when he came with supplies. Winter oil generally bad; sometimes good. Howland decides upon the quality and quantity of oil to be left. Left to keeper's judgment when to commence the use of summer and winter oils. Has never tried winter oil in summer, but is satisfied that the winter oil makes the best light always, when it is good. Chimneys not good; shape and size irregular. Burners, three and four concentric wicks. Burners of tin and not tipped with silver; they require repairs about once every three months. Two spare lamps allowed, but not kept ready for use in the lantern or light-room; they are kept in the machine-shop. They break from thirty to fifty chimneys, and burn about sixty yards of wick, per annum. Never trim during the night, except when bad oil is used. Watch takes charge from lighting until twelve o'clock, and from twelve to putting out in the morning. Clean up early in the morning. *Principal keeper does not keep watch*; goes to bed at 9 p. m. Assistants call the relief-watch by leaving the lights. No instructions framed and hung up, to guide keepers and assistants; a copy of translated instructions for keeping lens lights found after a search for it. No meteorological or other journal kept. No means for replacing broken glass at night; three spare panes of glass on hand. When repairs are required, writes to the agent of the collector to have them made. It would take half an hour to replace a lamp; none kept in the tower, ready filled for use. Lights never have been out. Finds no difficulty in managing the lens light. No instructions given except the book referred to, and a short printed letter, directing when to light up and when to put out, &c. Does not light up at sunset, because the person sent to inspect the lights told him not to do so. Puts out a little after daylight.

Dwelling leaks; stable and shop out of order. Lantern of revolving light contracted. Internal arrangement of the towers very bad. Keeper civil, and apparently anxious to gain information about his duties. He had no means of acquiring information. His predecessor remained only one night after being relieved; the assistants remained some time, and were finally dismissed by the keeper himself. The chimneys to the lamps are not properly fitted. The ventilation-holes fitted with doors, and in such a manner as not to fulfil the requirements of the service. The door of the light-room requires to be kept open in the winter, to prevent the smoke from the stove from filling the lantern. No proper means for warming the oil, and no alarum to the lamp, to give notice of any derangement to the valves. No system of supplies. Improper articles furnished; no means to guard against imposition. Articles except wicks (French) are generally bad. When oil is bad, tries another tank, and continues until the best of the lot is found. The best received of winter oil makes much the best light, as shown by the wick, which did not char. Howland leaves just what he pleases, for which the keeper has to receipt, and he refuses whatever he does not think proper to leave. Light-boat distant six to seven miles, and cannot be seen from the top of the light-house very frequently.

Remarks.—These two light-houses proved themselves vastly superior to the Sandy Hook light, at equal and at greater distances. It would be difficult to institute anything like a just comparison of them, as they were seen from sea on the night of the day they were visited.

Three keepers would be ample for these two lights. Place them in three watches; let one be on watch at a time, and if anything should occur, have one of the others called for the occasion, and continue until the difficulty is over. There is great inconsistency in having five keepers at Navesink, while there is only one at Sandy Hook. Three keepers at Navesink, under proper instructions and inspections, would keep the lights infinitely better than they are at present kept.

A—No. 3.

SANDY HOOK LIGHT-HOUSE.

June 3, 1851.

David J. Patterson, principal and only keeper; hires an assistant out of his own pay; no vocation at present. This keeper has charge of the two beacons in addition to the light-house—32 lamps and reflectors in all; 18 twenty-one inch reflectors in the main tower; 7 old lamps and 14-inch reflectors; tower, built in 1762 of rubble stone, in remarkable preservation; does not leak—is not damp; mortar still good; very small annual repairs required on this tower.

Inspected by Mr. Coggeshall and the master of the buoy-boat. Repairs made on dwelling-house this spring, and just finished painting in every part, ceilings, floors, walls, &c.; in the tower from lower floor to the lantern, machinery, dome of lantern. Paint put on apparently in a great hurry, and in a wasteful manner. Repairs to lamps and burners, and to oil tanks when required by Captain Howland, of the oil vessel. One lamp and burner left by Captain Howland. Lamps and burners placed in the

lanterns in 1842; several of the reflectors a little out of adjustment; scratched in cleaning; not very bright; fountains of the lamps dirty, and of an old pattern; burners bad and not clean; chimney holders are not well fitted—too loose—by which defect, many chimneys are broken; no one to put reflectors in adjustment when out. Lantern iron; astragals large and not diagonal; French plate-glass, about 24 inches square; glazed and pinned; interior of dome of lantern painted, but dirty and dark—said to have been painted four weeks since; ventilators bad and permanently closed; keeps the back door to the lantern open all the time the lights are burning, to assist the ventilation. Tower whitewashed inside this spring; outside has not been whitewashed for two years; dwelling in good condition—no leaks; dwelling not clean—paint daubed over the dirt.

Oil delivered by Captain Howland, May 26; summer oil 454 gallons; winter oil 198 gallons. West beacon, summer oil 182 gallons; winter oil 79 gallons. East beacon, summer oil 182 gallons; winter oil 79 gallons. Total for the 32 lamps and house 1,174 gallons; on hand for all, 70 gallons. Keeper took charge July 1, 1850.

Last year oil bad—winter oil cut with a knife; obliged to use it best way he could; supplies delivered once a year by Captain Howland; when bad supplies are left, obliged to use them, but requires more pains to keep the lights. Captain Howland leaves what he pleases, and decides the quantity and quality of the articles; keeper objected to the tube-glasses, and he gave ten more.

Depends on the weather as to the kind of oil to use; discretion used in lighting; does not light at sunset, and extinguishes at daylight. Has printed instructions to light up at sunset and put out at sunrise. Glass chimneys bad—complained of them to Captain Howland; burners of tin. Keeper has not been in charge a year, and cannot tell the amount of supplies consumed; *lamps never trimmed during the night*; cleans up in the morning and gets ready for lighting; keeper absent when he pleases—business calls him once in a quarter; leaves the man he employs himself in charge of the light; does not ask permission to be absent; makes a written report once in three months; no time-piece allowed; no thermometer or barometer; no spy-glass. Floating light $6\frac{3}{4}$ miles distant; is seldom seen at night from the top of the tower; makes out the light of the light-vessel with difficulty by the aid of a glass; six extra lamps kept on hand; Captain Howland orders all repairs on lamps, &c., without consulting the keeper; keeper has no other printed or written instructions; keeps no journal of expenditures of oil and other stores, nor of the weather; keeper had no instruction or training preparatory to taking charge of the light.

Predecessor gave no instructions about lighting.

No means are provided for rendering assistance to persons in distress. There is an old boat at the station belonging to the government, but of no use at present.

No orders to report lights that are out at night, nor to examine if all within range are lighted.

No storerooms in the tower for supplies; a dirty hole for supplies, without shelves or other means provided for keeping them. Lantern has no curtains.

Steps to tower painted—daubed on. Floors of house painted, instead of being scoured with sand.

BEACONS.

Stone foundations; wooden structures, clap-boarded; recently painted white outside, inside unfinished; rooms not in good order—dirty; stairs dirty; lantern, ditto—glass small size; seven lamps in each beacon, with 14-inch reflectors—old; taken from main tower when it was renovated. Lamps trimmed better than those in the light-house; holes for ventilation closed permanently with putty; only means of ventilation by opening door leading down the tower; closed the ventilators to keep the birds out! Oil kept as in light-house, on first floor. Tanks only marked with chalk; want of neatness everywhere.

Mr. Coggeshall stated that the Sandy Hook tower is less expensive for repairs than any one of the small towers in the district.

BUOYS.

The buoys in New York bay are without perches; and from the shape of the buoys and the position of the numbers, it is difficult to distinguish them; too small; should be nun instead of can, in most instances.

GENERAL REMARKS UPON LIGHTS FROM OUTSIDE THE BAR.

Light-vessel visible from upper deck of steamer, just before East Beacon and Sandy Hook light in range; invisible just after passing the range.

Sandy Hook light and Navesink revolving light appeared to be of nearly equal intensity when one and a quarter miles from East Beacon (estimated distance;) the light at Sandy Hook *orange* color, and the Navesink light *white*.

Sandy Hook light distant $2\frac{1}{4}$; Navesink light distant $5\frac{7}{8}$ miles.

Light at Princess bay, *dingy*; at Fort Tompkins, good; Robbin's reef light, pretty good.

It is evident that the revolving light at Navesink is more brilliant than the fixed light on the whole section traversed by the steamer, viz: from two miles southeast of light-boat around to one mile west of West Beacon, both to the naked eye and when seen through colored glasses, which exhibited one and not the other light.

Sandy Hook light is sufficiently good as an entrance or leading light, considering the Navesink as sea-lights.

It is not doubted that a second order French lens would be a greatly superior light to the present reflector light, and at a saving of oil equivalent to several hundred dollars per annum.

A—No. 4.

SANDY HOOK LIGHT-SHIP.

Captain Henry P. Lunt; two years in command.

Burden 230 tons; crew, ten men and one mate.

Two lights, fourteen round and two flat wicks; compass lamps, without reflectors.

Consume about 365 gallons of oil per annum.

Light seen from three to seven miles; no conductor.

Vessel in good order; moored with two mushroom anchors.

Three-inch chains and one-and-a-half-inch chain bridle.

Captain evinced great zeal for the service, and sensible of the want of good lamps and reflectors in place of the present lights.

No regulations or instructions furnished.

Keeps a regular journal of weather, vessels passing in and out, &c.

Vessel too old; bad model; rolls badly; unsafe; had extensive repairs last year; vessel well supplied with boats, &c.

Thinks a better model vessel necessary.

Said that no one visited the light-vessel to inspect, or see if they wanted anything.

Wants good apparatus to enable navigators to run for it with certainty; fog bell can be heard one and a half mile.

Vessel breaks from her moorings, and in getting her back much expense is incurred.

A—No. 5.

FORT TOMPKINS LIGHT.

June 4, 1851.

“Narrows,” New York; John Jennings, keeper—old man. Took charge August, 1849. Boatman and seaman. His predecessor remained one night to instruct him how to light his lamps. Had been in the same light when kept by another keeper.

Had received printed directions to light up at sunset, and keep a good light all night.

Nine twenty-one-inch reflectors, (parabolic,) brass lamps and frames; put up in 1849, in place of fourteen-inch reflectors and tin lamps; inferior reflectors.

Dome of lantern and interior of sashes dirty and black; want painting, badly. Lantern has not been painted since present keeper took charge. Plate-glass in that part of the lantern from which the light is seen, 26×10 inches.

Tower damp under the lantern and next to floor. Ventilators bad; difficult to use them. Birds get in when opened. They are sliding openings, difficult to regulate. Light not in good condition.

Inspected often by Mr. Coggeshall.

Keeper goes to New York for anything that he may require.

Chimneys, generally, not good; many broken.

Lights up after sunset. Trims at midnight, in summer; in winter, at 11 and 3. No means of knowing the time; gets up as near as he can at the proper time.

Oil-tanks without dripping-pans. No oil cellar. Tanks not marked, except with chalk. Oil on the floor. Want of neatness and cleanliness; although better than usually found.

A lamp raised with a wooden wedge to keep it up steady. No journal kept. No orders to keep an account of anything. Does not notice lights,

vessels, &c. Burns about forty gallons per lamp, a year. Last year one tank of winter oil was bad. House in good order and clean.

Tower about the condition of other contract towers, (Navesink, Princess bay, &c. ;) damp, but in pretty good preservation.

Fourth order lens light would be better for this station, at a saving of 230 gallons of oil per annum.

A—No. 6.

ROBBIN'S REEF LIGHT.

June 4, 1851.

Tower of cut stone ; erected on a foundation of the same, on the reef. Well built, dry, and in good preservation ; built in 1839, by contract. Richard Cary, keeper, took charge July 1, 1849. Absent ; found a small boy in charge, sixteen years of age.

Fifteen fourteen-inch reflectors in this lantern. Reflectors too small ; too many for true economy, and badly placed.

Light in very bad order—dirty ; and lamps not trimmed at 1 p. m. Lamps and burners out of adjustment.

Fog-bell worked by machinery ; strikes at regular intervals. Clock-work movement, and fly to regulate it. Wound up and set going from the inside. Weight of bell, 700 lbs.

The painters had just finished daubing the establishment. Floors of dwelling, steps of tower, and everything that could be painted, was covered. Wasteful expenditure of paint.

A fourth order lens-light would make a better light, at a saving of 470 gallons of oil per annum.

A—No 7.

PRINCESS BAY LIGHT.

June 4, 1851.

Tower built of rubble-stone, by contract, in 1828 ; Silas Bidell, principal and only keeper ; was stage-driver at time of appointment ; no instruction previous to taking charge of light ; took charge of light July 18, 1849 ; ten spherical reflectors, 14-inch diameter, tolerably good ; two spare burners from New York, not by contract ; tin, and very bad ; two spare lamps. Captain Howland delivered oil and wicks, May 29, 1850.

Winter oil-----	112 gallons.
Summer oil-----	275 "
Total-----	387 "

Keeper did not know how much oil consumed per annum. Howland left one common pair of scissors, (not trimming-scissors) one burner, two outside

burners, fifty tube-glasses, twenty-four yards cloth, one buff-skin, one box tripoli, one box of soap.

Howland soldered lamps and burners; did what he pleased; painted what was required two weeks since; whitewashed inside and outside two years since; used two kegs of paint, five gallons of oil and dryings, and one and a half gallon of turpentine.

Glass in lantern 10 + 12; broke and cracked, and not in good order; oil kept in basement of tower; tower wants whitewashing, and not in good preservation; badly built.

Lamps not trimmed at 9 a. m.; everything dirty, particularly in the lantern; does not light and extinguish as ordered; trims at 9 or 10, and at 2 a. m.; gets up by guess to trim lamps.

On hand forty-five gallons bad oil; had to burn it because he had no other; no written reports made; leaves the light whenever he pleases; leaves daughter in charge.

Has had no repairs for two years; tower and dwelling of same material, rubble-stone—cracked; dwelling out of repair and dirty; everything dirty.

Inspected occasionally by Mr. Coggeshall, the master of the buoy-boat, and by Captain Howland; keeper ignorant of his duties, and evidently not aware of the importance of keeping a good light.

A fourth order lens might replace this light to advantage, and at a great saving of oil.

A—No. 3.

LAZARETTO LIGHT.

June 9, 1851.

Baltimore harbor; William Shaw, keeper; has been keeper for twenty years; tower built of brick in 1831, condition good, well built; sea-wall requires repairing to save the work; light not inspected by any one.

Eleven lamps and reflectors, (spherical) three different sizes; badly placed, much worn; were second-hand when first put up in this tower; lamps very bad—leak; iron burners—galvanic action by contact with the metal of the lamp; oil bad for the last two or three years, evidently now bad—smells offensively; complained last year to the collector, of the oil; had to cut it in cold weather.

Two stoves in the lantern for keeping the oil warm; bad arrangement, and everything very dirty.

Sashes of lantern horizontal and very thick; glass very small; door to lantern could not be made to shut tight, except by caulking.

No ventilators; consumes about 450 gallons of oil per annum. Trims at 10 and 12 each night; keeps a regular journal of expenditures of supplies, the direction of winds and the kind of weather; purchases his own books and stationery for journals, &c.

Keeps journal voluntarily on his part.

Makes returns to the collector once every quarter.

Copper conductor to tower; dwellings and grounds in good order.

No cellars for oil; oil in lower part of tower; dripping-pans wanted; lamps and burners very inferior.

This light might be changed to a fifth order French lens, to great advantage, and at a great saving of money. In oil alone, not less than 400 gallons would be saved by the change.

A—No. 9.

BODKIN POINT LIGHT-HOUSE.

Mouth of Patapsco ; bay and river light.

William H. Glover, keeper, appointed March 28, 1849 ; relieved the widow Tatem ; was a blacksmith and boiler-maker by trade ; had no knowledge or instruction previous to taking charge ; had received the usual printed instructions only ; lights up after sunset, and puts out at sunrise ; gets his lamps ready for lighting before sunset.

Has no measurer to measure the oil ; guesses at the quantity of oil used, by the gallon measure, the only one he has ; trims only at 12 o'clock ; in the winter trims at 10 and 2, or 2½ ; has no means of ascertaining the hour of the night.

Thirteen 16-inch parabolic reflectors ; lamps and reflectors in very bad order ; lamps brass, burners bad ; lantern small, glass 9 + 10 ; no ventilators—smoke escapes through top of the lantern only ; soot very thick over the dome, and the whole lantern black and dirty ; filled with cleaning-rags, broken chimneys, &c.

Oil last year very bad ; this year better.

Tower built by contract ; rubble-stone, like all those which have been seen, that were built in this manner ; new painting pretty good ; inside wood-work bad ; dwelling of rubble-stone ; cistern in good order ; never inspected before, (keeper ;) at 11½ a. m., nothing clean or ready for lighting ; copper conductor ; keeps a journal of weather, and expenditures of oil, (latter guessed at ;) consumed last year upwards of 520 gallons, but could not show the exact quantity consumed ; compelled to use the bad oil, because they do not take away bad oil.

The keeper's son and little daughter commenced taking down the lamps and reflectors so soon as the keeper saw the collector with us.

Lamps, burners and reflectors very dirty ; the burners were so full of carbonized wick and dirty oil, that it would not be possible to produce a reasonably good combustion ; chimneys very much smoked, showing clearly that the light is not perfectly kept.

No trimming-scissors.

A—No. 10.

BOMBAY HOOK LIGHT.

June 26, 1851—9 a. m.

Delaware bay ; Duncan Stewart, keeper—89 years old ; daughters keep the light. Built in 1831, and rebuilt in 1841, on the top of the dwelling. Built by Winslow Lewis ; unfinished ; no plastering of tower.

Ten 13-inch reflectors and tin lamps, common burners; reflectors of thin copper and a very thin film of silver-plating, much worn off in spots; not firmly placed on the frame, and easily put out of adjustment. Lantern small, glass 8×12 inches; sashes thick and black—want painting very much; the frame of the dome and lantern very dirty for want of paint. Lantern leaks very much; until rebuilt, leaked in every part of building; tower so open that it is difficult to carry a light into the lantern; wood-work rough and not planed; floor of lantern coppered; no curtains allowed; Captain Howland tinkered up the lamps and burners in May; four spare lamps, burners very common. House wants painting; spouts, &c., rusty for want of paint. A well, in good order; a pump (pine) put in last year, but it injured the water.

Inspected last June by the collector. Oil generally good. Captain Howland generally makes repairs of lamps, &c., &c., as required. No lime allowed for whitewashing; whitewashed by keeper at his own expense.

Roof of the house very open—places a quarter of an inch between the shingles; brick-work rough; floors not tongued and grooved; rough and open in the attics; garret-rooms not plastered; wooden pillar, supporting steps, much worm-eaten; cellar in bad order—wants cementing and repairs; kitchen in cellar; oil smells badly.

May 20, Captain Howland delivered winter oil, 100 gallons; summer oil 138 gallons.

Common scissors—no trimming-scissors; trims the lamps at midnight during summer. So far as the keeper's duties are concerned, the establishment is in good order, neat and clean.

Repairs to the out-houses, &c., neglected by the contractor who undertook the work.

A—No. 11.

REEDY ISLAND LIGHT

June 26, 1851—11 a. m.

River and harbor light; Ephraim L. Lockerman, keeper—middle-aged—farmer; keeper makes the gas and attends to the light-house himself. Took charge January 27, 1850.

Had no instruction, except one night by a man from Philadelphia; makes rosin gas once a week; has not been inspected since last June.

Brick house; granite steps; roof of house leaks badly; ventilators circular, and rude in construction.

Nine 15-inch reflectors and burners; reflectors of different patterns—part spherical and part parabolic, bruised and scratched—thin plating; glass in lantern $10\frac{1}{2}$ by $13\frac{1}{2}$.

Dome inside black, and wants painting badly; chimneys or tube-glasses bad; sashes and astragals painted white inside; sea-wall, done by Middleton two years ago, wants looking after.

Painted three weeks since; previous to that, very dirty, and had not been painted for a long time; water-tank, holding 800 or 900 gallons; arch supporting lantern, and just below it, very damp and discolored—not whitewashed for two years; iron framed windows—do not fit, and leak. Oil on hand, 65 gallons. Water gets into the gas-pipe, and required to use oil for four nights; commenced burning gas February 18, 1850. Two new retorts

every fifteen months, cost about \$180. Consumed, from May 2, 1850, to August 2, 1850, 35 bushels of rosin, 81 bushels coke, 1 cord of wood; clay, one bushel per quarter.

Nine lamps consume ordinarily about 360 gallons of oil; gas costs about \$350 per annum.

Received, May 19, 1851, twelve new 14-inch spherical reflectors and brass lamps and burners; plating thin; frame for putting up, to burn oil; use 12 lamps when oil is burnt. Reports all necessary repairs. No apparent necessity for the new lamps and reflectors.

A—No. 12.

BEAVER TAIL LIGHT.

June 30, 1851—11 a. m.

Harbor light. Fog whistle apparatus, by C. L. Daboll. Reservoir 200 cubic gallons, 30×60 inches.

Two pumps, 3 inches diameter, working 8-inch shaft; fills the condenser in $7\frac{1}{2}$ minutes with slow gearing, or in 4 minutes by fast gearing.

Fog seldom lasts all day. It will require about one-third of the time (during fogs) to work the horse, to keep up a regular series of signals. Keeper makes fog signals when he wakes up and finds a fog. No means of ascertaining if it is foggy; generally gets up at 1 a. m. to trim lamps. Whistle-house 24×20 feet; wheel 10 feet in diameter, working into a 14-inch pinion; 3 minutes per signal, or 12 minutes for 4 signals.

LIGHT-HOUSE.

Demarius H. Wheaton, widow, keeper of the light-house. Took charge May, 1848, when her husband died. Husband took charge April, 1844.

Fifteen lamps and reflectors; 15-inch reflectors (spherical.) Lights at sunsetting and puts out at sunrising. Inspected once a year, in June. Has not been inspected for a year.

Keeper's son, twenty years old, has charge of the light; had no instruction or training previously; trims at 1 a. m.; lantern $8\frac{1}{2}$ feet diameter; good size; wants paint badly; frame miserable; glass in lantern varies in size— 12×12 generally; burners of different kinds, and bad; reflectors old, scratched, thin plating; no painting inside of dome and lantern; fountains of lamps leak badly. Worst built tower yet seen; built of soft shale; greatly out of repairs; has not been repaired for seven years, since present keeper has had charge; whitewashed two years since; tower inside and out in wretched condition; bad materials, and mortar very poor; pieces of the material ready to fall out; cracks from base to lantern; wood work in rapid decay; badly done in the first place; steps of stairs resting on iron spikes in part.

Oil consumed last year: summer oil, 331 gallons; winter oil, 189 gallons; total 520 gallons. Windows without arches, resting on window lintels, and no masonry to support the work above. Door very open, and causes oil to freeze. No supplies since last July. Tube-glasses bad; of different lengths and sizes. Reported all bad supplies to superintendent.

"Must use them," was the reply; "when these are used up, more will be supplied." Common scissors in place of trimming-scissors. Oil tanks in bad order; tops do not fit; reflectors scratched and badly used. Dwelling-house painted last year; wants shingling; leaks; floors and walls settled; windows leak; work extremely bad; has always been so; conductor resting on dry ground, about three feet long from side of tower; no conductor to house; chimney leaks and smokes; no cistern; well, with water brackish; use a hoghead to catch water to wash with.

Capt. Howland remains only a few hours, and leaves what he pleases. Commences burning winter oil about 1st December, and continues all the winter; receipts for as much as he says he leaves; has no means of knowing whether right or not.

Keeper gives certificate to persons who are sent to make repairs, upon their assertion that they have complied with their contract. Does not know if she is competent to judge of the work, and knows nothing of the terms of the contract.

A—No. 13.

NEWPORT LIGHT.

June 30, 1851—2½ p. m.

Harbor light, on north point of the breakwater. Pardon Stevens, keeper for two years, (absent.) Everything managed better than in any light visited before. Eight spherical reflectors, 14-inch diameter, in one circle, very clean; lantern just painted white inside. Tin lamps; burners, as usual, bad, but clean; lantern good size; floor of arch for lantern, of large faces of granite (sienite.)

Reflectors ought to be arranged better for a harbor light. Tower of masonry in courses; inside hammered, outside rough; laid in full cement, pointed, and covered with asphaltum; spiral stairs of stone; windows fit better than seen before. Large leaders extending through the body of the work; ventilators plugged up with wooden plugs; cannot be regulated; wants whitewashing outside; conductor of iron led into the water.

Tower constructed under the direction of engineer department; oil tanks clean and labelled; everything in order. Tube-glasses arranged on a shelf; first thing of the kind seen; matches in boxes; oil tanks in stands, with dripping-pans; no dripping-pan found in any other light-house visited.

Dwelling repaired last year; leaks; repairs amounted to painting and whitewashing.

Oil last year very bad; this year better, (wife.) Trims once only during the night.

NEWPORT AND NARRAGANSETT BAYS.

Two additional buoys required near the end of Goat island; also a buoy on the "Sisters," a ledge of rocks at the north end of the "Bishop," near Coaster Harbor island, in Narragansett bay. This ledge is in the track of vessels passing up and down Providence and Taunton rivers.

A—No. 14.

NORTH POINT LIGHTS—TWO LEADING LIGHTS.

July 9—2 to 3½ p. m.

Mrs. E. Riley, keeper; assistant, deaf and dumb son, who performed the duty of keeper to both lights: has kept for 23 years; nine spherical reflectors in each light, in good order; glass in lantern $8\frac{1}{2} \times 10\frac{1}{2}$; astragals horizontal, $\frac{9}{16}$ inch thick; octagonal frame, $3\frac{1}{4}$ inches wide, 8 uprights.

No trimming-scissors. Lamps tin—clean; burners bad—clean. Tower rubble-stone, badly built; pointing good; stucco bad; tower dry; oil at 70° Fahrenheit; 10° below sperm by standard oliometer.

Bridges or wharves require repairs badly; tower requires a little painting; foundation requires a little repair to save further expense.

Has kept the lights for 23 years. No winter oil on hand; usual complaint.

Reflectors are not well placed to produce the greatest intensity of light in the required azimuths.

Fifth or sixth order lenses might be substituted to advantage, and produce a great saving of oil.

A—No. 15.

CHESAPEAKE BAY.

June 18, 1851.

Passed Sharp's island light within about three to four miles. It was not visible through lightest green glass. Evening had fairly set in. Two lights on steamboat, coming out of Choptank, visible through same glass within two miles.

Passed Cove Point light, visible through same glass.

Smith's island (E. shore) not seen.

Point Lookout fair, six miles distant.

Smith's point very dim; captain and pilot say that it is the worst light in the bay.

Light-boat at five miles, fair.

Coming out of the Patapsco, examined the question of colors for buoys, * * * * * and the pilot came to the conclusion that red buoys will be seen better when projected upon the water.

That color must be scarlet, and not dark brown, to give the best effect.

A—No. 16.

WILLOUGHBY'S POINT LIGHT-BOAT.

Entrance to Chesapeake bay; (old revenue steamer Spencer;) John B. Sale, captain—appointed 1848. Moored by Captain Evans, revenue cutter Madison; single chain, and one anchor—1,800 pounds; seventy fathoms

1½ inch chain; mushroom anchor close to Willoughby's Point reef (shoal) swings around.

Three hundred tons, iron; built 1821. Heaves in chain often. Examines moorings three to four times a year. Thinks better to moor with a bridle and swivel. Lights forty-two and forty-three feet from water-line; wicks one and one-fourth inch in diameter.

Captain, three men, one cook, and one mate; captain in service twenty-nine years. Mate gets \$18; men \$15; cook \$10 per month; and found one revenue ration per day.

Kept away a year for repairs in 1849; moved once since 1848; never broken adrift; log well kept on board.

Bell for fogs heard from five to six miles to leeward; not over a quarter of a mile to windward, if blowing fresh.

Spare anchor 1,000 pounds; sixty fathoms cable.

A red and white buoy kept as a substitute in case of breaking away.

Lantern four feet five inches by three feet three inches; burner in a bowl or gimball, (compass lamp,) common glass.

Ship clean, and in good order; ship rolls a good deal.

A—No. 17.

CRANEY ISLAND LIGHT-BOAT.

Channel light; John Tee, master; one light; placed five years; thirty-seven fathoms chain; mushroom anchor; vessel seventy-two tons. Light thirty-four feet from water-line; 274 gallons oil in six months; eighteen pounds wick per week; three hands, \$18, \$15, \$10 per month. Not moored; lantern too small, and miserable lamp. Has broken adrift; log well kept. Account of wind and weather—passing vessels; has circular from Fifth Auditor for instructions; has a fog-bell, which may be heard five miles to leeward; 250 pounds weight. One spare anchor, 456 pounds, and forty-five fathoms chain. No substitute. Ship in bad order.

A—No. 18.

CAPE HENRY LIGHT.

June 19, 1851.

Main sea-light; coast light—fixed. Light-house on sand-hills near point of cape, and 600 to 800 yards from beach; site preserved by open board fences. Basement of stone around light-house.

James Atkinson, only keeper—appointed five years ago; hires an assistant himself; does not feel at liberty to be absent at night; obliged to be absent sometimes; collector authorizes him to be absent, provided a good man is left in his place.

Tower built in 1791, of sandstone of Potomac, outside; soapstone coping; rubble-stone inside; common masonry; mortar pretty good; two iron conductors.

Visited by collector of Norfolk last May for inspection; whitewashed once in two years; no other repairs; none on keeper's house, except such as he puts on himself; is a mechanic, a cabinet-maker; would go to collector if house required much repair.

Eighteen lamps and 21-inch parabolic reflectors; tin lamps, brass tops—parlor-lamp form, and structure not the brass kind we have seen; lamp-glasses gave out a week ago, and has now to put one broken one on another; Captain Howland expected daily; ducks sometimes break glasses of lantern; astragals 16+24, some thick and some thin glass.

Seven-eighths of the horizon illuminated.

Lamps oldest kind; burners common; no regular lamp scissors for trimming; common Argand burners, cup, &c. Mirrors in good order—plated copper; deep parabolas; oil burns well; new oil-heaters, such as seen before; wicks not well trimmed; reflectors cleaned with tripoli; lime for whitewashing from collector; white paint for sashes; dome red inside, black outside; whitewashes once in two years.

Astragals small; burners in line of sash-bar; has a box of good common glass; putty for glazing; sashes of iron.

Interior of lantern painted with Spanish brown; lantern ventilated with twelve sheet-iron ventilators, $5 \times 4\frac{1}{2}$ inch; ventilators closed up.

Soapstone floor to lantern; very dirty with oil; warm in lantern; eighteen lamps kept it warm in winter.

Moderately clean, except in lantern; glass not clean.

Curtains for three sides; no covers for reflectors; tower whitewashed inside and out; steps also, but now worn off.

Keeper's house, &c., in very good repair; no oil cellar; no storerooms; whitewashing required to dwelling in two rooms.

Foundation to building good.

Supplied with oil, &c., once a year by Captain Howland: no bad supplies received.

Burners $\frac{3}{4}$ -inch diameter; brass not silvered. Burners last about twelve months. Old burners taken away by Captain Howland; he repairs the lamps, &c. Two spare lamps; no reflectors. One hundred chimneys left each year; gave out this year; they break mostly in winter. Leaves seven gross of wicks per annum. Lights at sunset; puts out just after day-break.

Trims when they get cool; does not wait until sunrise to put out lights. Trims when he thinks it necessary; can tell from the window of the chamber where he sleeps; goes to bed at 10 o'clock; trims twice before 10 o'clock; sometimes trims afterwards. Frequently wakes assistant, and sends him up to trim, &c.; no regular watch kept. Have one copy of printed instructions at home; none hung up.

Reports every quarter to collector of Norfolk, number of gallons of oil used, quantity received, quantity on hand; tube-glasses, wicks, &c., &c., on hand, and used. Sets down daily consumption, but only reports quantity per quarter; three-gallon pot for measuring; it takes that to fill lamps up; draws three-gallons, and charges only per quarter.

Smith's island light, (Cape Charles,) light-boat, and Old Point, seen; looks out for lights; none out.

Once reported to collector as bad; reported to Mr. Pleasanton, who wrote to collector; had a few days before reported lamps in bad order;

burners ditto. Mr. Howland waiting to repair them; but could not land, owing to bad weather.

Tower laid in courses; Potomac red sandstone; stone walls; N. to S. W.; feldspar and quartz; granite (so called,) laid in cement; keeper's house fenced in; fences by present keeper; some of them six feet high.

Six hundred gallons of oil consumed last year.

A—No. 19.

NEW POINT COMFORT LIGHT.

Bay light; serving also for York river.

Isaac Foster, principal and only keeper; retired sea-captain; (has five sons at sea.) Appointed January, 1847; has a negro woman of his own to assist him in keeping the light.

Salary \$400, and no allowance for an assistant; desires an allowance for wood; is on an island. Tower of sandstone; ashlar outside, rubble inside; whitewashed inside and out; present condition good; leaks a little above, but stopped with putty; loose stone about foundation.

Visited by collector for inspection. Mr. Howland daily expected to deliver supplies.

Lantern six feet in the clear; fixed light; lamps, burners, and tube-glasses, as usual, common; $\frac{6}{7}$ of the horizon below, $\frac{1}{7}$ above of the horizon, illuminated.

Reflectors scratched; want silvering as well as cleaning; two extra lamps, which keeper thinks not enough, as they give out and are not always well repaired; tube-glasses indifferent.

Tower too low from last floor to platform; fifty feet from platform to sill of door; glass 24×16 inches. Interior of dome painted white; no curtains. Ventilators as usual; trap-door closed; moderately clean. Tower painted and whitewashed; reported in good condition; wants locks and catches; oil in cellar of house.

Dwelling is a frame-house, painted white. Oil does not freeze in cellar, but gets thick in winter. Foundation of building good.

Receives supplies once a year.

Burners, as usual, $\frac{3}{4}$ -inch; not tipped with silver; burners get out of order often.

Lights up at dark and puts out at daylight; turned down in putting out; keeper thinks there is no use in lighting at sunset! lights up in a few minutes.

Trims at 11 or 12 in summer; in winter at 10 and 2 o'clock. No watch kept, but always wakes at the right time.

Has the usual printed instructions; keeper says the light is not considered bad in the bay; keeper thinks curtains of no use! there are none.

SATURDAY, June 21, 1851.

Passed light-boat at the Wolf-trap, at $7\frac{1}{2}$ p.m., and not lighted; said to be well kept by an old sea-captain. It has broken adrift several times. Buoy down, ahead of light-boat; light-boat has two lights.

Rappahannock light-boat, two lights; showed well; said by captain of the Georgia to be well kept, by an old captain.

Smith's Point light-house, as in going down, was exceedingly dim. The light on Cove Point was also dim, though better than Smith's Point light. The tower is too low.

A—No. 20.

BACK RIVER LIGHT.

June 20, 1851.

Revolving bay light; also for Back river harbor.

William Jet, principal and only keeper; twenty-two years keeper.

Is now sick; saw his son, but not the assistant keeper.

Questions generally answered by son, who does not reside here, (son about thirty years of age;) assistant appointed by keeper—negro man.

Brick tower, leaks on platform above; wooden stairs; wooden tube for weight; revolving light, without air-fly to regulate it; will not start of itself; sometimes gets out of order; is not now in good order.

Light was reported as out when it stopped once; collector inspected it once; no repairs made; lamps arranged on two opposite parallels, three below and two above; lamps like those of Cape Henry, nearly; reflectors small, thirteen inches; three of them old; seven of them fourteen-inch; burners as usual; mirrors clean; wicks well trimmed; tower moderately clean; lantern small; glass 12×9 , small panes; lower row iron.

Astragals thick iron; dome black inside; ventilated by small holes below; shuts trap-door when he goes out; establishment moderately clean; tower whitewashed inside and out; wood-work painted lead color; keeper's dwelling in very good order; wants whitewashing; oil in lower part of tower; house raised by blocking around, say three feet high; bridge to light-house say sixty yards long. In a late storm, water washed away the garden and rose to near the top of wharf. Around the tower is wharfing, filled in with stones and mortar; done by Gibbons by contract; wall of tower is hollow, filled in with bats; oil-cans want painting; moderately clean; foundation (?) clay soil, below sand. Average consumption is twenty-four gills (three quarts) per night of oil; supplies furnished annually by Captain Howland; lights up at dark and puts out after daylight; wipes off the snuff; trims at ten and two o'clock; winds up clock-work for revolving at the same time; sits up until ten o'clock; wakes up regularly; no regular watch kept; no place to stay in; very warm now; uses stove sometimes; has heaters which are used, and stove also; does not know of any instructions; makes returns to collector quarterly.

Cape Henry, Willoughby's Point light-boat, New Point Comfort, and when the weather is good the Wolf-trap light-boat, are seen from the top of the tower; no special record is kept.

The colored man has been engaged in light-keeping since his boyhood. Walls of tower of good brick; cracks pointed up; there are white curtains to go up; site of light-house in danger from the sea; cistern in good order, but spouts leading to it in bad condition; depends upon rain-water; no cloth for covers—only for wiping.

A—No. 21.

OLD POINT COMFORT LIGHT.

June 19, 1851.

Bay or harbor light; William C. King, keeper; kept a shoe-store before taking charge of light; appointed August, 1849; never knew his predecessor; has no assistant; leaves only to get his pay in Norfolk, and then does not stay away all night; would not feel authorised to leave without permission of collector; was absent once, but left a person to take charge.

Does not know when built; cut dark stone outside, rough inside; driving rain beats in, not through walls; no painting; upper part requires it.

Collector was at light-house three or four weeks since; visits it but once a year; no repairs made except whitewashing; tower whitewashed once in two years.

Fixed light; has been seen outside the capes; six-sevenths of the horizon illuminated; five-sevenths above; eleven lamps in all; lamps like those at Cape Henry; lamps smoke; reflectors fourteen-inch diameter, shallow; spherical to iron frame; reflectors scratched; lantern hot; about six feet in the clear; same kind of burners as at Cape Henry; window-glass 16×24; ventilation of lamps and lanterns bad; always smoke; no glass broken since he has had charge; has five panes of thick glass; dome black inside; light-house clean.

Tower whitewashed inside and out; keeper's dwelling, &c., &c., in good condition; a few panes of glass required; rain beats in a little under the windows.

Oil-house separate from dwelling and tower; oil above ground; keeper's house frame building; stone oil-house; no other storerooms; no cracks in foundation.

Supplies left once a year; sorry oil left last year; Mr. Howland offered to take it away, but he thought he could use it; burns from three quarts to a gallon per night in summer, and one and a quarter to one and a half gallon in winter.

Lamps not now in perfect order.

Burns his own lights, and not the public's; no bad articles received; would report bad articles to the collector.

Oil consumed in a year 486 gallons; eighty-six tube-glasses; twenty-nine yards of cloth for towels and curtains; keeps curtains up; four gross wicks, one buff-skin, one pair scissors; one box tripoli, one box soap, three burners repaired complete.

Lights at sunset, and puts out a little before sunrise.

Trims every four hours, 10 and 2 in winter; trims after putting out in the morning; gets up regularly; gets up once or twice to look at lights; no regular watch kept; same printed instructions as others, put away in a drawer; no written reports made of the condition of the light; reports orally; only quarterly returns of tube-glasses, oil and wicks. Cape Henry light-house is seen from lantern of this light, also light-boat off Willoughby's Point.

No record required of lights seen at night; no lights seen from this lantern reported out.

Hears fog-bell of light-boat without difficulty, with northwest wind; hears it say three miles off.

Instructed to keep wicks even and snuff every two hours; hired the boy that his predecessor had, and used him for six months at his own expense.

Oil-room clean; oil sometimes gets thick, but never freezes; has no heaters.

Whole establishment convenient.

A—No. 22.

PORTLAND HEAD LIGHT.

July 5, 1852.—11 a. m.

John F. Watts, keeper, seaman. Had no previous instruction; had not received any printed or written instructions to guide him in keeping the light; employed a man two days to teach him how to keep the light. Thirteen 21-inch reflectors, put up in September, 1850. Has no trimming-scissors; common seamstress scissors furnished. Lamps and burners put up in September, 1850; reflectors scratched; polishing-powder bad; frame too light; reflectors improperly placed in the frame, especially with reference to the sashes of the lantern. They require to be raised and placed closer together; if not placed closer, several will continue to be useless, as they are towards the land. Lantern new last September; took off top of tower and built it up anew in consequence of leaks; lantern floor of pine under sheet-copper; plate-glass, 30 by 21; sashes vertical and horizontal; no closets or storerooms (as usual) for supplies; no paint or whitewash for two years; no curtains; lantern painted red inside; nine feet in diameter; good size for the apparatus; one pane of spare glass; trims every night at midnight; oil always bad, and all of it; lights up after sunset; (common whale oil, not sperm.)

On the 20th of May showed the oil to the United States marshal, who said it was ridiculous to expect good lights from such oil. It looked like lard oil; has to warm it till late in the spring; winter oil no better than summer oil; supplies delivered only once a year; reports the oil when bad, but obliged to burn it; got twenty gallons from the collector; does not keep a journal; makes reports quarterly.

Received August 23, 1850-----	300	gallons	summer.
	156	"	winter.
	40	"	on hand.

Total-----	496	gallons.
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Has a fog-horn, and blows it for steamers, (private arrangement.) Dwelling-house in bad order; walls cracked; windows leak; no repairs since present keeper took charge; no painting or whitewashing; has a well for water. Tower built of rough rubble masonry of trap rock, laid in lime mortar, pointed with cement; cracked and a good deal undermined by the rats, owing to holes being left of old beams when the new flooring was put in. All the wood-work of soft wood.

A—No. 23.

ISLE OF SHOALS LIGHT.

July 7, 1851—11 a. m.

Sea-coast light; revolving red and white light, one face, red tubes. D. Shepherd, principal and only keeper; took charge July 15, 1849; school-teacher; had no previous instruction; predecessor gave a few days' instruction. Fifteen reflectors on a triangular frame; five on each face, varying from nineteen to twenty-one inches in diameter, nearly all different. Only two parabolic in shape; plating very thin; burners not in adjustment; lamps very bad: lights up generally about sunset, and puts out a little before sunrise; trims at midnight during summer, at 9 p. m. and 2 a. m. in winter. Does not use the ventilators properly or understandingly.

Has the usual printed instructions, and no others. Oil pretty good, most of it. Reports bad supplies. Mr. Howland leaves what supplies he pleases of oil, &c. Last year got bad tube-glasses from him; got glasses from collector; wicks also bad; colored chimneys of different shapes; collector had great difficulty in getting them of the proper shape. Light revolves once in three and a quarter minutes. Part of the oil kept on lower floor of tower, and the winter oil in the cellar of the dwelling. Cellar of dwelling dirty and filled with barrels, &c.; has a tank for water. Tower built of rubble masonry, covered with boards and shingles; conductor of copper, and led into the water. Lantern frame of iron; glass 20 by 48 inches; plate-glass, seamed; towards the harbor of Portsmouth 14 by 18 inches. Keeps a day-book or journal, but could not furnish the quantity of oil consumed last year from it. Makes quarterly returns, but does not keep copies. Has no timepiece. Floors of dwelling painted, and also the steps of tower in part—waste of paint. Buoys in the harbor, &c., too small, and chiefly spar-buoys.

A—No. 24.

CAPE ELIZABETH LIGHTS, NEAR PORTLAND, MAINE.

July 4, 1851—4 p. m.

Sea-coast light; east light nearest point fixed; west light revolving. William Jordan, principal and only keeper; took charge July 12, 1849. No previous instruction in the management of lights. Had the man who had been keeper previously to show him. Tower built (east light) of undressed hard slate, in 1828-9, laid in very inferior lime-mortar; pointing cement very good; windows and towers leak badly; frame of lantern around glass leaks badly; tower damp inside; walls discolored and cracked; want painting badly; conductor not carried far enough off, and lying on the ground.

Thirteen 21-inch parabolic reflectors; plating very thin, and in some of them off in spots. Lamps of copper, and pretty good; burners one inch in diameter, and common, as usual. Common scissors for trimming. Lanterns too small; plate-glass, 26 by 18. Lights up at sunset—puts out at sunrise. Bad ventilators; can only be used with difficulty. Stove and oil

heaters. Trims in summer at midnight—in winter at 10 and 2 o'clock. Has been no painting, whitewashing, or pointing for two years, except lantern painted red inside last year, and new vane put up; has had no lime for two years. Burners not very clean. Fog-bell 1,560 pounds; struck by machinery once in ten seconds; machinery out of order; stops occasionally; reported to the collector, but not repaired. Building for bell in very bad order. Machinery runs for two hours and fifty minutes; bell heard in calm weather two or three miles; with light wind it cannot be heard further than to the beach, about one hundred yards. Has no spare glass for lantern; has had generally very bad oil; reports the oil, but still compelled to burn it. Receives supplies only once a year, in July or August. Oil in cellar of dwelling, and on floor of light-towers. Dwelling in pretty good order; leaks in heavy rains; no whitewashing.

West light, revolving.

Fourteen 21-inch parabolic reflectors; lighted July 4, 1850. Lamps and reflectors on two faces; three broken panes of plate-glass; one very badly broken; plate-glass 30 by 22 inches; lantern painted red inside; ventilators tolerably good. Reflectors thinly plated; one of them bruised. Lantern entirely too small; not very clean; clock-work movement; revolves once in four minutes; dark from thirty to forty-five seconds. No journal kept; no account of oil consumed per night; makes quantity agree with quantity on hand. Tower wants looking after; the towers of these two lights pretty well built, but greatly neglected.

The keeper of these lights and fog-bell seems desirous of keeping good lights, but is wanting in proper instruction. Burners not clean; wicks not well trimmed; lantern and glass not dried since the rain of the forenoon. The lamps and reflectors of the revolving light are not well arranged; being on two faces, makes it difficult for the keeper, through want of room, to attend to the lamps while in motion. This establishment has evidently been greatly neglected for some time. There should not be less than two keepers to these lights, and one of them constantly on watch during the entire night.

A—No. 25.

BRANDYWINE SHOAL LIGHT.

June 24, 1851—4½ p. m.

Fixed third order, larger model, French lens—Henry Lepaute, constructor, Paris; two concentric wicks; two inches diameter, the larger or exterior one. John Burton, keeper; three men with him to man his boat and assist in taking care of the light and building; took charge when first lighted, October 28, 1850; every thing clean and in good order; thick plate French glass in lantern, 30 by 32 inches diameter; lamp consumes $1\frac{19}{100}$ gills per hour of oil, including consumption for dwelling; keeper had difficulty, when he first took charge of light, with the lamp, but has no difficulty now;

has never been instructed how to manage the lamp; interior of dome well painted white, and not smoked; painted in February last; regular watch kept; keeper repairs lamps, &c., &c. Fog-bell, with clock-work movement, strikes seven times in thirty seconds—interval of thirty seconds; bell 500 pounds weight—hammer 14 pounds; water tank will hold 1,050 gallons; oil-tanks of heavy block tin, well painted—no leaks; floors clean and free from oil-spots; five places or berths for men.

Towers on screw-piles—protected by screw-pile ice harbor or breakwater, constructed by Major Hartman Bache, United States topographical engineers; very little vibration—rather a tremulous motion than any other; coal-bunkers, storerooms, &c., very complete; clock, barometer, and thermometer allowed and used by keeper. Has all the necessary tools for making repairs; water-filter, and medicine chest; ten water-casks of twenty gallons each; three water-casks of thirty gallons each; keeper makes regular reports on the bottom, consumption of stores, &c., to Major Bache, who has charge. The light is in admirable order, and the keeper deserves great credit; he had never seen a Carcel lamp before the one placed under his charge in this light-house. Ran out from Brandywine light—elevation 45 feet above the level of the sea—third order fixed lens light—until it bore, per compass, northwest by north; Cape May light-house north $\frac{3}{4}$ east, and Cape Henlopen light-house west by south $\frac{1}{2}$ south, which gives the following distances from the coast survey chart:

From Brandywine light-house 15 miles.

“ Cape May “ $8\frac{3}{4}$ “

“ Cape Henlopen “ $6\frac{1}{4}$ “

The board having watched the appearance of these three lights, going down the bay, concluded that the Brandywine light was more brilliant, from the point designated, than either the one on Cape May, distant $8\frac{3}{4}$ miles—a revolving light—or the one on Cape Henlopen, only distant $6\frac{1}{4}$ miles. The comparison was continued, under the breakwater, when the previous conclusions were confirmed. Distance from anchorage, under the breakwater, to Brandywine light-house, $13\frac{1}{2}$ miles; to Cape May, $12\frac{1}{2}$ miles; and to Cape Henlopen, two miles. That is to say, the Brandywine light, a third order Fresnel lens, is, in brilliancy, $5\frac{3}{4}$ times greater than the Cape Henlopen reflector-light, fitted with eighteen 21-inch reflectors; and three times more brilliant than the Cape May revolving-light, fitted with fifteen reflectors.

The consumption of oil being in favor of the Brandywine light, viz:

Brandywine light consumes between 161 and 183 gallons.

Cape Henlopen “ “ 581 and 720 “

Cape May “ “ 506 and 600 “

A—No. 26.

CAPE HENLOPEN LIGHT.

June 25, 1851.

Sea-coast light. Stone tower, built in 1764; laid in courses and filled in with rubble-stone. Well built; stone rather small. Walls, at lower

floor, six feet, and at lantern four feet thick. Stairs of wood, clean and in good order.

William Elligood, principal and only keeper; took charge May 16, 1849. Farmer by vocation. Eighteen 21-inch parabolic reflectors, in good order. Lamps and burners not good; though better than usual. Numerous spots on reflectors without silver.* No paint for two years, (since present keeper took charge.) Dome and sashes of lantern black inside for want of paint. Glass 16×24 . Inspected June, 1850, by collector, and not since. Ventilation bad, and no proper means for regulation of stove under the frame. Astragals vertical. Lantern eleven feet in diameter. Lights up at sunset, and puts out at sunrise. Lights with care, and seems to understand his duties. Lantern leaks and keeps the upper part of tower damp. Tower whitewashed once in two years. Has spare glass for lantern—no means of replacing glass at night. Keeper not satisfactorily furnished with supplies; particularly paint, glass, putty, &c. Oil cellar under tower not used. Good temperature; oil gets a little thick, but never congeals. Howland left two new tanks this year; empty; not required; three old ones condemned. Summer oil stood the test of the oliometer within 3° . Winter oil worse, being 7° less than standard. Oil last year very bad. Burned much less last year than usual.

June 18, Captain Howland delivered, winter oil 204 gallons.

do.	do.	do.	summer oil 478	"
For beacon, ten lights, 14-inch,			winter oil 100	"
do.	do.	do.	summer oil 206	"

Has no rule for delivery of oil; delivers what he pleases. He says (Captain H.) it is so much, and he has to receipt for any quantity he may say he delivers. Writes his own receipts and requires the keepers to sign them.

Last year, first quarter, 152 gals. winter.

"	second "	15	"	"	121 summer.
"	third "	00	"	"	138 "
"	fourth "	52	"	"	103 "

219 + 362 = 581 gals. total.

Makes regular returns to the collector. Howland repairs what is necessary with his tinker. When bad oil is on hand, is obliged to use it. Calls often on the collector for tube-glasses, &c., &c.

Keeper has charge of main light and beacon; \$400 salary for main light, and \$250 for beacon light. Trims at midnight. No regular watch kept. No instructions framed and hung up. Impossible for one man to attend to these duties alone. Howland comes once a year with supplies. Keeper makes repairs to lamps, &c.; keeps an account of oil and supplies expended, including consumption of house. Two conductors; one without a point, and ought to be taken down. Wall cracked to northwest. No curtains in lantern. Dwelling leaks about the eaves and windows. Foundation of house undermining, and requires looking after at once. Dwelling built in 1820. Paving around tower out of order, and requires to be looked after, to prevent rapid deterioration, and, possibly, danger to the building. Tower 84 feet from base, 164 feet above tides; built of ashlar granite, or

* Fitted up in 1840, at the same time that the English reflectors were put in the Boston light.

gneiss; inside rubble masonry. Lightning-rods of iron. Mortar good. Iron band around top of tower; iron very much corroded. Flat brick arch to support the lantern. Soapstone floor. Arch leaks and appears to be yielding; requires immediate attention. Keeper's house leaks a little on east side, and in eaves; foundation undermined by rats on west side; walls cracking in consequence; foundation built of pretty good masonry, originally. Fences settled and in a state of dilapidation. Sand advancing towards tower and house. Pine tops, generally laid annually 200 to 300 loads, at a cost of fifty cents per load, now decayed. Old building near tower ought to be removed; in bad condition, and adds to the movement of the sand by creating eddy currents of air. Measures ought to be taken to regulate the movement of the sand.

A—No. 27.

BEACON-LIGHT.

10½ a. m.

For a range and harbor light. Ten 15-inch reflectors and lamps, bad; lantern miserable—stove-pipe through the side of it; lantern about 3½ feet too high, (seven panes of glass;) water runs through the lantern, keeping everything in bad condition; tower of rubble-stone masonry—no repairs for two years; everything in a wretched condition; threatened with being carried away by the sand; wood-work inside, rotting and going fast; whole establishment in wretched condition, and if not repaired soon, will become unfit for use; no curtains up; keeper complains very much of not being supplied with necessary articles, to enable him to keep his light in order; paint, whitewash, &c., required; no dripping-pans to tanks; tanks not marked, except with chalk; repairs made by direction of a Mr. Middleton, last year, who gave it out for a fixed sum, and never came to see if it was properly executed; tower about forty-five feet high, of sienite; wood-work rapidly decaying inside; masonry of tower very inferior, and giving way, not worth repairing; sand encroaching on tower; board-fence around it, and in bad order. The point, during heavy gales, is submerged several feet.

A—No. 28.

CAPE MAY LIGHT.

June 25, 1851—4 p. m.

Sea-coast, revolving. Fifteen reflectors on three faces—ten of them 15-inch parabolic and five of them 14-inch spherical, old and much worn. Downes E. Foster, keeper; 44 years old; carpenter by trade. Light revolves very irregularly--assumed to revolve once in three minutes; no instructions as to time of revolutions; no ventilation, and finds it impossible to keep a good light when the door of the lantern cannot be opened; thin copper below the glass in the lantern; lantern too high, and not of sufficient diameter; cramped for room.

Tower built in 1847, by Samuel Middleton and Nathan Middleton, contractors; tower 78 feet high; keeper took charge April, 1850; removed predecessor; no training or experience before taking charge; no instructions as to the mode of doing the duty; thin plate-glass 20×28 in the lantern; no paint in dome or frame of lantern—painted black originally; astragals and sashes rusty, and greatly in want of paint; iron conductor; rough square box for leading weight of clock-work movement down; wood-work rough beyond anything seen before; supports to stairway not planed; everything rough and unfinished; tower damp, from base to lantern; a rough hole through the arch of lantern floor for leading weight to clock-work; the whole thing rude in the extreme; cement in this hole good and perfectly hard; tower wants whitewashing outside and in; stairs leading to lantern clean; trims lamps once every night; leaves the light at 9 o'clock and returns at midnight; lights up after sunset, when he thinks it right to do so; extinguishes lights a little before sunrise. Has a copy of written instructions from collector, (appointment.) Has no printed instructions; never received any. Keeps a tally of oil consumed by light-house and dwelling combined; oil always good; received oil from Captain Howland, June 21: summer oil 354 gallons, winter oil 152 gallons; no rule as to the quality or quantity left; no supplies bad; no trimming-scissors; no repairs since keeper came here; Captain Howland overhauled lamps, repaired burners, and put in new burners; two spare lamps and burners; does not know when light was inspected, but not since about June, 1850; reported condition of the walls—need whitewashing; has never been supplied with paint or whitewash; no putty; no repairs on buildings except oil-house; no brooms or brushes for cleaning; good water, well out of order; got discouraged at not getting what he asked for, and did not apply any more; cannot tell when the tower was whitewashed inside—outside last spring; burners bad, $\frac{7}{8}$ inch; no storerooms or shelves for wicks, chimneys, tripoli, &c.; summer oil very offensive to the smell; winter oil not so bad, very light color; Howland left two tanks, of bad tin, (thin.) No journal kept; makes returns once a quarter in the usual form; collector at Wilmington, Del., is the superintendent. Dwelling built in September, 1847; leaks through the walls in a stream; rain drives in at the windows; plastering broken; whitewashed three weeks since; windows loose; oil consumed last year for house and lamps, 449 gallons; (evidently a bad light, and great want of ventilation;) Howland wanted to know what had been done with the oil over and above the quantity used by the keeper; Captain H. sounds the oil-tanks, determines what is on hand, and leaves what quantity he pleases; keeper receipts for the quantity he says he leaves; has no means of ascertaining the quantity; does not know how much the tanks hold; Captain Howland remains less than half a day, usually; no clock allowed; finds his own timepiece.

This is a boat-station for wrecks. Boat-house locked; keeper has not charge of it; it is in charge of a person not far off; called on the keeper of the wrecking apparatus and examined it.

A—No. 29.

DELAWARE BREAKWATER LIGHT.

June 25, 1851—1 p. m.

Thomas J. Truxton, principal and only keeper. Built October, 1849; stone foundation, brick above; by contract, by Nathan Middleton; floor of lantern pine plank covered with sheet copper; leaks so badly that it is almost impossible to occupy apartments below; it always leaked; present keeper took charge of the old light May 22, 1849.

Tower supported by three piers of masonry of coarse gneiss, laid in courses, with brick arches and brick superstructures; lime-mortar; tower for lantern of wood. Six 14-inch spherical reflectors; miserable things and badly used; scratched and bruised; new when put up. Dome of lantern caulked with canvass to keep out the wind and rain, (stuck around lower part of dome;) no curtains; lamps are bad; iron burners put in last year; the six reflectors are on two frames, moving horizontally, independent the one of the other; three thick red shades to cover three of the reflectors; inspected last year by the collector, (one year ago;) oil and other supplies received in May, from Captain Howland; glass in lantern 20 by 14 inches; astragals vertical and large; lantern never good; copper broken adrift above the gallery; dome black with soot; sashes black; no paint; dirty; no ventilation; no proper place to keep the oil, &c., &c.; oil kept in the old light-house; two water-tanks, holding 3,572 gallons of water each, collected from the house.

Tanks are placed in the arches, which were built to allow the sea to pass through it under the house—apparently to pass the tide wave; but the tanks are placed so far below the level of the crown of the arch, it must necessarily intercept it, and endanger the whole building. The tanks are very deficient in support.

Present keeper certified that the work was faithfully done, because the contractor brought him a certificate which he said the collector desired him to sign. He signed it, knowing that the work was not well done; would not do so again. Keeper had no directions framed and hung up. Oil good now; bad last year; reported it, but was obliged to use it; none sent to replace it; kept a fire in the light-room constantly in cold weather; reported the condition of the building to the collector quarterly; nothing done; sees the Brandywine light from lantern better than any other light; Brandywine light greatly superior (in keeper's opinion) to all the other visible lights.

Reports oil consumed by *average*; no measurement of oil kept daily; oil for house included in consumption.

It is impossible to see the red portion of this light, if at all, at a greater distance than a mile to a mile and a half.

The light is not located on the spot which it ought to occupy, because the breakwater is not yet completed to that point; and it is believed that the old light, which is yet standing, would have subserved the purposes of navigation as well as the new one.

A—No. 30.

PORTSMOUTH, NEW HAMPSHIRE.

July 7, 1851—5½ p. m.

Harbor light. Wooden frame tower, shingled. Granite foundation; in good condition.

William Vennard, keeper; took charge June, 1849; farmer—no previous instructions. Has the usual printed instructions. Thirteen 14-inch reflectors. Reflectors (spherical) old and much worn; lantern small—glass 11×13 inches. Not cleaned up at this late hour; dome of lantern black inside—all dirty—everything very dirty. Oil spilled on the floor and steps. Trims every four hours. Oil last year very bad; this year good. Received oil 16th August, 1850; none since. Receives supplies once a year. Lantern leaks a little around the gallery. Inspected once a year. No curtains and no proper trimming-scissors. Oil-tanks, as usual, on the lower floor of tower.

A—No. 31.

LIGHT-VESSEL OFF MINOT'S ROCK.

July 8, 1851—1 p. m.

Old boat from Brandywine shoal, of about 110 tons burden; moored with old cables; too small; 45 fathoms in each, and a span of 45 fathoms. Illuminating apparatus like all the other light-boats. Keeper absent. Mate came on board during the visit of the board. This very important point requires a boat of greater tonnage, and built on the best model, to resist the heavy seas. The moorings are insufficient. Keeper and mate should not be permitted to be absent at the same time. Keeper was absent during the recent visit for inspection by the collector. Boat dirty and apparently not well cared for. Painting outside and in. Four persons on board. Boat in bad condition, apparently. This boat ought not to be kept in so important a place, as it will be impossible to keep her at her moorings during the winter months.

A—No. 32.

BOSTON LIGHT.

Revolving sea-coast and harbor light. William Long, principal and only keeper—was a sea-captain. Fourteen 21-inch English parabolic reflectors; lamps and burners American. Plating and reflectors good—scratched in cleaning. Depth of reflector $8\frac{3}{4}$ inches; $6\frac{1}{2}$ inches for ordinate; placed on two faces only. Lantern, iron. Plate-glass, 24×36 inches. Ventilators good—circular—resembling furnace registers. Lantern too small for present arrangement of the lamps and reflectors; keeper absent. Dome of lantern and inside sashes, if not black, not very clean. Iron floor and iron stair-

case. Tower of rough-hammered masonry, laid in courses with lime-mortar, well pointed. Arch to lantern floor of brick; dry inside; six iron bands around the tower outside. Tower wants whitewashing inside and out, and a little painting. Two copper conductors—one broken and neglected by the keeper; all the bands of the tower touching the conductors. Tower cracked. Fog-bell moved by machinery; weights or hammers too light. Keeper took charge October 20, 1849. Does not light up at sunset, and puts out before sunrise. Has a cistern for rain-water. Cellar for oil under dwelling not in order. Oil-tanks want painting. No curtain to protect the apparatus. Dwelling-house in good order and clean. Buoys in the harbor and its approaches too small; generally spar-buoys, and small of their kind.

A—No. 33.

CLARK'S POINT LIGHT, NEW BEDFORD.

July 9, 1851—4 p. m.

Harbor light. Henry U. Smith, principal and only keeper. Took charge November 3, 1843. Lighting apparatus new. Nine 16-inch spherical reflectors; put up four weeks since; plating very thin; reflectors very badly made; plating blistered in several places. Tripoli for cleaning very bad; cannot use it; uses crocus purchased by himself. Reflectors well placed (by keeper;) depth, $5\frac{1}{2}$ inches; half ordinate, $4\frac{1}{2}$ inches; glass of lantern 24×16 . Does not trim the wicks—rubs them off. Lantern new. Everything clean; cast-iron floor to lantern. Brass lamps and burners of the usual pattern; burners $\frac{3}{4}$ inch. Inside dome of lantern and sashes just painted white. Hitherto it was all black, (keeper.) Lights at sunset, puts out at sunrise. No trimming-scissors; oil very good always. Tower built in 1806, of rubble masonry; just painted and whitewashed; keeps no journal. Gauges his oil every three months, and makes his returns accordingly. Dwelling-house leaks badly in the roof. Good order generally, and clean.

A—No. 34.

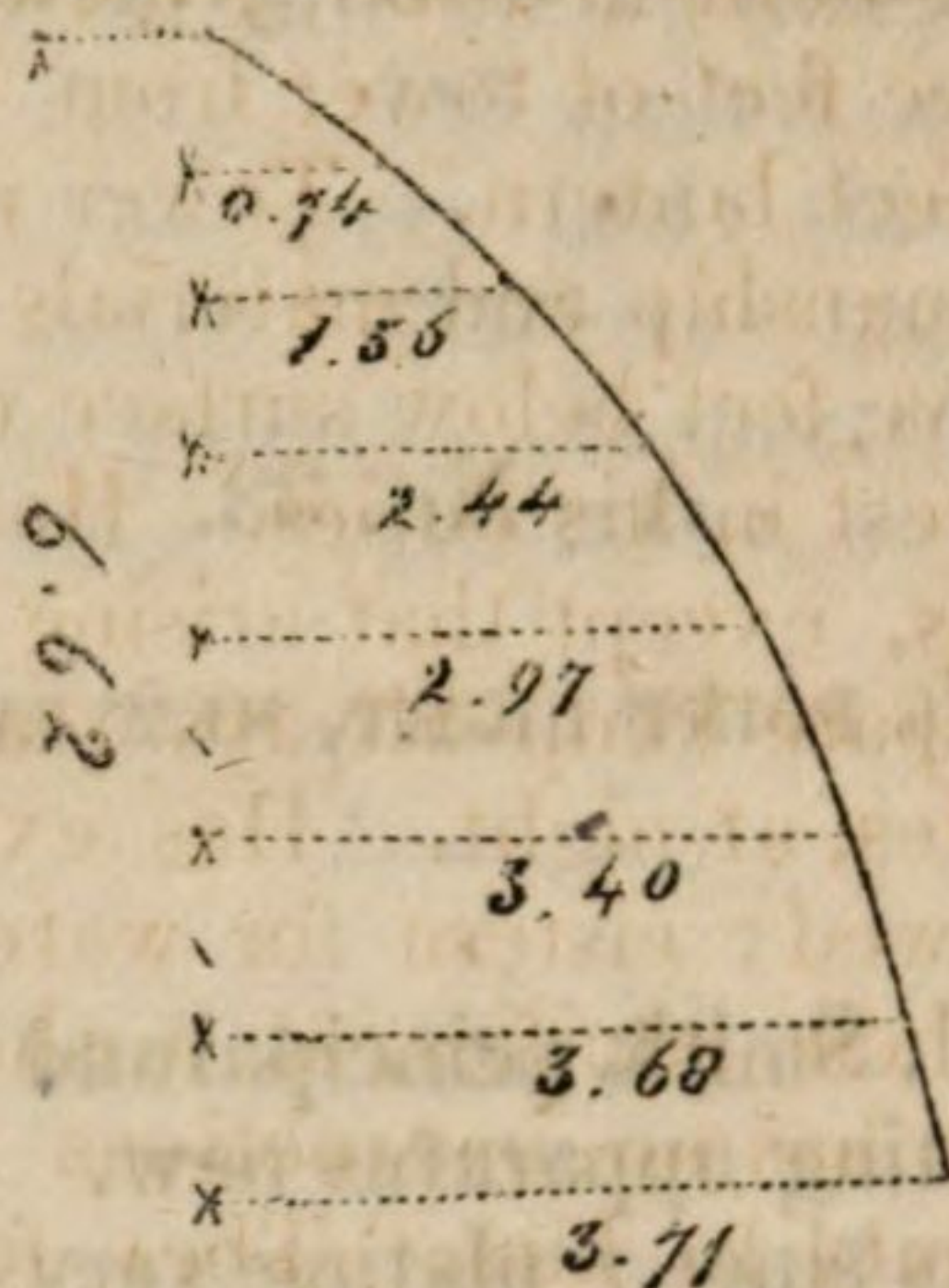
MATTAPOISETT, NED'S POINT, NEW BEDFORD.

July 9, 1851—6½ p. m.

Bay light. Larnet Hall, jr., principal and only keeper. Took charge June, 1848. Previous occupation stage-driver; had no previous instruction in light-keeping; has the usual printed instructions furnished. Eight 13-inch reflectors. Tin lamps—common; lantern small—leaks; no curtains; (oil-cloth on floor, furnished by keeper.) Glass 9×10 ; dome black; sashes white. Inspected once a year. Howland furnishes oil and other supplies once a year. Tower painted this spring; whitewashed and pointed very recently; badly built of rubble masonry, thirteen years ago. House leaks in roof and chimneys. Keeper bought a pair of trimming-scissors out of his own funds. Common scissors left by Howland. No ventilators.

Opens door of lantern to ventilate and produce proper combustion. Lights up at sunset and puts out at sunrise. Does not keep a journal; makes no returns to the collector. Oil bad; reported it; burns it from necessity. Just painted and cleaned up. Trims every four hours throughout the whole year. Conductor detached, and instead of being of use, is a source of danger; its importance not understood. Everything very clean.

Reflector at Ned's Point light, Mattapoisett, near New Bedford, Massachusetts.



Measured.		Calculated.	Remarks.
Ordinate, inches.	Abscissæ, inches.	Abscissæ.	
6.62	3.71	4.2	Tried the circle, but it will not do near the vertex.
5.62	2.77	3.0	
4.62	2.15	2.1	
3.62	1.27	1.3	
2.62	0.74	0.7	
1.62	0.31	0.3	
0.62	0.03	0.04	

A—No. 35.

SANKATY HEAD LIGHT, NANTUCKET ISLAND.

July 10, 1851—6½ p. m.

Dioptric light, second order; movable, with the annular portion of the lenses in two pieces, in brass frame, the frame being in the focal plane.

Alexander D. Bunker, principal keeper; commanded a merchant ship for twenty-five years; salary \$600; salaries of the two assistants, \$360 each; three watches kept, the principal taking his regular turn; keeper took charge when it was first lighted, February 1, 1850; had no previous instructions in the management of the lens light and lamps; lantern octago-

nal; one spare mechanical lamp; three spare burners; lens, lamps and glass of lantern in good order. Everything had the appearance of care and attention from the keeper; lantern leaks; made of iron, painted white inside; cast-iron floor; lamp placed on cast-iron pedestal. Plate-glass 54×28 inches, $\frac{7}{16}$ of an inch thick; revolves once in eight minutes. Instructions written out and furnished by the officer who superintended the putting up of the lens, &c. The division of the annular portion of the lens, by a metallic frame, destroys much of its useful effect. A plate of red glass was shown by the keeper, as a specimen of the set to be put in the lower half of the lens, to produce red flashes, to be seen at the distance of not more than seven miles. Tower built in 1850, by Cabot King, by contract; iron spiral staircase; fifty-three feet of tower from base, of brick; the next six feet of granite, and nine feet lantern. Tower requires some stucco outside; double windows. Workmanship and materials of tower good; cement and hard brick; foundation five feet below surface of *brick*; keeper intelligent, and manifests much interest in his duties. Has had no difficulty in managing the mechanical lamps, except that arising from bad oil, which he has had frequently; keeps a spare lamp always ready for use, and can change the lamp in fifteen minutes, at night. Has extra cords for movable machinery; has a clock allowed; cistern for water. No quarters for the assistants; they live with their families, at a short distance, perhaps a mile or two. Principal keeper has no instructions for his assistants, and they do not understand their duty to him. They feel independent of him and his orders, in a great degree, which produces difficulty. Principal keeps a regular account of oil consumed each night.

1851, July 1, on hand-----	87 gallons.
1850, July 24, received-----	253 summer.
“-----	204 winter.
	457
	87 off.
Total consumed in eleven months and seven days-----	370 gallons.

This light is very highly spoken of by sea-faring men.

A—No. 36.

BLOCK ISLAND LIGHTS.

Two fixed lights; these two lights appeared only as one light, in passing from Newport to New York; very dim, seen only a few miles. Beavertail, Point Judith, Watch Hill and Block Island lights are all inferior. Buoys too small and badly painted; red very bad.

A—No. 37.

BUOYS AND BEACONS—CAPE FEAR RIVER AND BARS.

The buoys, with one exception, are casks resembling ordinary oil-casks, capable of holding about sixty gallons. There is one nun-buoy, with a staff, above the light-boat, and a beacon further up the river, composed of a pole sunk into the bottom, with an ordinary-sized barrel on it. The barrel-buoys may possibly answer in the upper part of the river, but are most improper marks for bars. The sinkers are not heavy enough to keep them in their places. A steamboat is employed by the year to keep the buoys in their proper places, but weeks elapse after they have drifted, before they are replaced. The outer buoy on the main bar was removed by a very moderate gale; and although several weeks have elapsed, it is still out of place, (October, 1851.) The buoys are numbered with large figures, but the red color is of such bad paint that it is difficult to distinguish them from the black ones. Good red paint, on the water, shows better than any other color, under ordinary circumstances.

A—No. 38.

ORTON'S POINT LIGHT.

This is the first light passed in ascending the Cape Fear river, after leaving the light-vessel. It is a small reflector light, on the dwelling of the keeper. The whole building bears evidence of bad construction, and a most injudicious location. The water at ordinary half-tides, washes the walls (of brick) of the dwelling. It bears marks of premature decay.

Eagle or Big Island light is very similar to the one on Orton's point. The same defects are apparent. The location, if possible, is worse than the Orton point light. The exterior bears evidence of rapid deterioration.

The light proposed for the upper jetty is quite unnecessary. Some of the lights already established are of doubtful utility, in this vicinity.

A—No. 39.

LIGHT-SHIP, CAPE FEAR RIVER.

Simon Griscom, keeper; not on board. Found the vessel in charge of a negro boy, who said he was about fourteen years old. Vessel anchored with a chain and an anchor. Light like all the rest seen in the United States, with seven small wicks placed in a square frame, with glass 7×9 inches, badly put in; glazing occupying a large space on the edge of the glass. The vessel dirty in every part. In the hold two oil-tanks, an oil-barrel and some empty water-casks; some chains piled up—supposed to be spare moorings. The keeper of this vessel is reported to be a regular active pilot.

Had no means of ascertaining by whom the vessel is cared for, except the boy's answers. This is a miserable light, seldom seen at the anchorage off Smithville, a distance of three to five miles. Decks wanted wetting and cleaning, to preserve them.

A—No. 40.

PRICE'S CREEK.

Two beacon-lights; one 35 feet and the other 25 feet in height. John Bell, keeper. Range-lights for the channel; lighted January 1, 1851. High light in wooden tower on keeper's house. Keeper's house brick; leaks badly all over; lantern and sashes black inside, and dirty; wants painting white; leaks badly. House clean inside; materials of which built, bad. Gutters out of order; want repairs badly; material is too thin for the purpose. Furnished by the collector with 444 gallons of oil; by Howland, in May, 125 gallons of oil. Trims twice during the night. Has a cistern for fresh water. Kitchen smoked so badly that it could not be used; built one himself. Work received from Mr. Wood, the contractor, by two citizens of Wilmington and the collector. Has the usual instructions from the Fifth Auditor. Had no experience in keeping lights before he was appointed to this; used to hang up two hand-lanterns for the steamboat company. Brick tower (lower light) leaks badly through the lantern. Eight 14-inch spherical reflectors in each lantern. Soapstone floor to lantern of lower tower. Reflectors loose on the frame and not placed properly; two in each lantern of no use, their light being thrown on the land and woods. No conductor to brick tower. Copper conductor to dwelling and higher tower. These two lights are too close together for a good range and of very little use, so far as could be learned of those who it is believed are most interested in them.

A—No. 41.

BALD HEAD LIGHT (CAPE FEAR.)

Francis Morse, principal and only keeper; (is a pilot, and follows his vocation of piloting;) took charge at his father's death, April, 1848. Fifteen 21-inch reflectors; ordinate, nine and a half inches (not true parabola); burners three and a half inches from apex; plating of reflectors not good—has a clouded appearance, leaden hue; impossible to make them as bright as good silver should be; frame very slight, shakes in turning. (In Mr. Pleasanton's corrected list this light is put down eighteen 21-inch reflectors, while there are only fifteen.) Glass in lantern 24×16 . Astragals vertical, very thick and broad. All inside of the dome of the lantern black, and wants paint badly. This light is notoriously bad; and the keeper thinks it worse than before the new reflectors were put up, in December, 1849. The shape of the reflectors, doubtless, has much to do in producing so bad a light as this certainly is. Lamps pretty good; burners as usual. Reflectors too far apart on the frame. Wood-work rough, and not planed; badly put together. Floors loose in numerous places; wooden lintels and sills

inside; pieces of pine timber jutting out from the walls in various places. Interior of tower said to be filled in with pieces of wood. No journal kept; makes quarterly returns. Consumed last year 423 gallons of oil, (not enough to keep a good light;) oil was good, but has sometimes been bad.

This establishment is as clean as such a one could well be kept. Wants repairs about the base outside. No storerooms for spare glass, lamps, &c.; no oil cellar; tanks rusty, and not in good order; oil leaking about the floor. The same system of delivering supplies exists here. Keeper never instructed in keeping a light; thinks he knows his business well; is absent a good deal, and in his absence his family attend upon the light. No curtains for lantern; lantern large and roomy; no difficulty in getting around the apparatus. Tower is not properly placed. It is of no use in crossing the bar; and to be useful, as a sea-coast light, it ought to be on the pitch of the cape, some four miles nearer the Frying-pan shoals, outside of which it ought to be seen, although it is doubtful if it can be seen ten miles under ordinary circumstances.

From the anchorage, a distance of from two and a half to three miles, the beacon-lights on Oak island are more brilliant, although one is twenty and the other only thirty feet high, with ten lamps in each.

This point (Cape Fear) ought to have the most powerful lens light that can be made, and the tower removed to the pitch of the cape, and given an elevation of one hundred and fifty feet.

At this anchorage there are in sight,

Oak Island beacons-----	2 lights.
Price's Creek beacons-----	2 "
Bald Head-----	1 light.
Federal point-----	1 "
Light-boat-----	1 "

Total lights-----7
containing sixty-two lamps and reflectors, besides the lamps of the light-boat.

For Bald Head a first order revolving lens light, or a flashing light-----	570 gallons.
Price's creek, two beacons, sixth order-----	80 "
Oak Island, " " "-----	80 "
Federal point, fourth order lens-----	80 "

Total for lenses-----810 gallons.
Sixty-two lamps, at forty gallons each, now-----2,480 "

Saving annually -----1,670 gallons,
or about \$2,500, and having at the same time greatly superior lights.

The Bald Head light is comparatively useless, owing to its bad location and dimness. Had it been placed near the pitch of the cape, elevated one hundred and fifty feet, and fitted with a first order lens apparatus, it would be seen beyond the dangerous Frying-pan shoals, distant twenty nautical miles, and at the same time serve as a leading mark for the bar at the entrance of the harbor. Height of glass portion of lantern, six feet; diameter of lantern, ten feet; ventilators, sliding, six inches square, with shelving convex sides, not used. Distance horizontally between the reflectors, from edge to edge, four inches. Distance vertically between edges of up-

per and lower tiers of reflectors, four and a half inches. Diameter of reflectors at centre of burners, twelve inches. Centre of burner from apex of parameter of reflector, three and a half inches. Diameter of reflector, twenty-one inches.

A—No. 42.

NEW INLET—FEDERAL POINT LIGHT.

September 4, 1851—m.

James Newlin, keeper; appointed October, 1849; was a pilot. Eleven spherical reflectors, $12\frac{1}{2}$ inches diameter; burners $2\frac{1}{2}$ to 3 inches from centre to parameter of reflector; very bad order throughout; common tin lamps; leak badly; reflectors bad; plating worn off; spotted all over from water through leaks and from trimming lamps; not cleaned to-day; glass in lantern 8 by 11; every thing inside of lantern black with soot, and rusty; lanterns too small to allow keeper to get around the apparatus; every thing very dirty; oil spilled from the lantern to the floor; ventilators bad, and not properly used. Lights at sunset and puts out at sunrise. Has plenty of glass, but no putty. Oil bad; could not give the quantity consumed last year. Has difficulty in getting tube-glasses when they are out; obliged to use broken tube-glasses. Whitewashed about five years ago; no lime allowed. No journal kept. Has only one box of soap; very small. Keeper returned an hour after the light-house was reached; light evidently very badly kept. Keeper has had no instructions. Tower too low. Frame movable, and only nine lamps lighted in good weather; lamps and reflectors not properly placed at night, to show to the best advantage to the most desirable parts of the horizon.

This light, seen at the anchorage at Smithville, a distance of about seven miles, is very dim on a clear night with the wind from the N. W. The same objection exists in this case to a movable frame as usual, as it leaves the keeper to place it properly or not, as he pleases; according as he is informed upon the subject or not. The light from this tower, as seen on clear nights from the anchorage at Smithville, appears like two lights, one above the other; which results from the reflectors being out of adjustment. It has frequently been seen that the reflectors are thrown out of their proper positions, by wooden wedges being placed so as to raise the fountain to make the oil flow freely.

A—No. 43.

OAK ISLAND—TWO BEACON LIGHTS; CAPE FEAR RIVER, N. C.

September 2—11 a. m.

John G. Brickman, keeper; took charge September 3, 1849; worked on Fort Caswell previous to taking charge.

These two lights are placed about 130 yards apart, and serve as leading

marks to cross the Oak Island bar; too close together. Keeper leaves the lights to go to Wilmington for his pay.

Towers were built in 1849, of brick; look very well; lime-mortar; do not leak; one 20 feet and the other 30 feet in height. Lanterns of heavy iron. Astragals vertical and very broad. Glass of lantern 28×12 inches. Ten reflectors, 14-inch spherical, in each tower; very badly placed on the frame; three of one and four of the lamps of the other entirely useless, in consequence of their being placed around the entire circle, without regard to the object of the lights. The lights of three of the lamps in the tower nearest the sea were thrown upon the iron door of the lantern and the woods to the westward. Lanterns very small; no room to pass around the apparatus. Inspected once in two years by collector at Wilmington. Supplied with spare glass, but no putty. Lantern and dome inside black with soot, and has never been painted white. Both lanterns dirty; reflectors scratched and inferior in construction; lamps pretty good; burners as usual; four spare lamps and burners. No trimming-scissors. No journal kept; cannot read or write; does not know how much oil is consumed each night. Gets a friend at the fort to make quarterly returns for him. Oil is always good.

Received June 9, 1851-----	427	gallons summer oil.
	134	" winter oil.
	561	
	106	" on hand.

Total----- 667 gallons.

Lights up at sunset, puts out at sunrise; trims at midnight in summer; does not understand lighting or trimming lamps. Lights are decidedly bad; burners and lamps apparently are never cleaned out; glass of lantern not kept clean; no curtains; towers want whitewashing; wood-work not neat. Dwelling-house in good order; pretty clean; water from a cistern; in good order. Gave instructions to him about keeping his lights; lights improved during stay in that quarter; every thing very common; had no instructions when he took charge.

If these lights had been put on wooden piles, they would have cost less, and, at the same time, would have answered a better purpose. Now, they are threatened by the sand.

APPENDIX B—No. 1 to 40.

CIRCULAR LETTER OF THE LIGHT-HOUSE BOARD, AND REPLIES TO IT,
RELATING TO THE FOREIGN AND UNITED STATES LIGHTS.

B—No. 1.

Circular addressed to commanders of mail-steamers, packet-ships, &c.

OFFICE LIGHT-HOUSE BOARD,
Washington City, May 29, 1851.

SIR: I am directed by the light-house board, convened in this city by order of the Hon. Secretary of the Treasury, in conformity to a late act

of Congress, to inquire into the condition of the light-house establishment of the United States, and to make a detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection, and superintendence, to solicit from you any information which you may possess upon the subject of light-house improvements, and as to the present condition of lights and other aids to navigation in the United States.

The board is desirous of availing itself of information from all reliable sources upon this highly interesting and most important subject to the maritime world; and as your position and opportunities afford you ample means by which to form correct opinions as to the comparative superiority or inferiority of such lights of this and of other countries which you may have had occasion to observe carefully, it relies confidently upon you to furnish, at your earliest convenience, such a statement of facts and opinions as your experience may dictate.

With the view to place the subject in its most tangible form, the following queries are submitted, to which answers are respectfully requested, in addition to any information and opinions of a general character which you may be pleased to communicate.

1. How many passages do you make on an average per annum, and between what ports?

2. What lights do you run for in those passages?

3. What the location and character of the foreign lights—the description of apparatus employed in them, their comparative brilliancy, range, steadiness, and certainty of being lighted during the entire period of time from sunsetting to sunrising—to those of the United States in positions of equal or greater importance to over-sea voyagers?

4. What the general character of the lights of this country compared to those of Great Britain, France, and the West Indies, with reference to usefulness, range, and brilliancy?

5. What the best sea-coast lights of this country, and how do they compare with the best lights of other countries (please name them) which you have seen, with reference to range and brilliancy?

6. How do the lights on the coast of the United States compare with those of Europe, &c., in their characteristic distinctions?

7. How do the light-vessels on the coast of the United States compare with those of Great Britain as to usefulness, certainty of position, brilliancy, and range of light.

8. How does the system of buoys, beacons, and sea-marks of the United States compare with that of Great Britain?

The board will be pleased to receive any information relating to particular localities or portions of the coast, with reference to additional aids to navigation, to modes of distinguishing lights in special localities, &c., &c.

I am, very respectfully, your obedient servant,

THORNTON A. JENKINS,

Lieutenant U. S. Navy, and Secretary to Light-house Board,

B—No. 2.

Letter from Captain W. B. Cropper, commander of the ship Isaac Webb.

NEW YORK, June 29, 1851.

SIR: I have just received yours of the 29th ult., and hasten to reply.

I have been 23 years in the trade between New York and Liverpool, making six passages per year.

Cape Clear is the first light we run for, next Tuskar, and then for Holyhead. Those lights are of the first-class, and can be seen at the distance of from 20 to 25 miles. I do not know in what manner they are lighted. They are lighted at sunset and burn till sunrise. The lights on the coast of Ireland and England are much better than those on our own coast, with the exception of the Highland lights near Sandy Hook, which can be seen from 20 to 27 miles.

The lights are much better in all parts of Europe that I have visited, than they are in the United States.

The light-vessels in the United States which I have seen, are all inferior to those in Great Britain, and are badly lighted and badly attended to.

I think a good light-vessel on the South shoal off Nantucket would be of very great use to mariners.

I think a light-vessel might be moored off Nantucket South shoal, as there is a number of light-vessels in England as much exposed as that would be. The Coninbeg light-vessel, off the Great Saltees island, on the south coast of Ireland, is moored with 180 fathoms of chain in 20 fathoms of water, and it has not broken away for 25 years.

The buoys, beacons, and sea-marks of our coast are very inferior to those of Great Britain; they have more of them, and they are better placed and better marked.

In passing into a harbor in Great Britain the buoys on the starboard hand are red, and on the port hand black, and at the elbows or turns of the channels they are striped. They are also marked and numbered, and have the name of the channel to which they belong. The buoys on the different sides of the channels are of different shapes and form.

I think that our light-house system should be looked into, for we have great room for improvement.

Yours, &c.,

W. B. CROPPER,

Master ship Isaac Webb.

Lieutenant T. A. JENKINS,

Secretary to the Light-house Board.

B—No. 3.

Letter from Lieut. David D. Porter, United States navy, commanding United States mail-steamer Georgia.

JULY, 1851.

SIR: I have received your communication of May 29, with enclosed act of Congress relating to light-houses, and hasten to lay before the board such

information as I possess on the subject. I also do it with great pleasure, as our light-houses as at present arranged are so wretched, that any seafaring man must desire a change; and I am confident that the intelligent gentlemen composing the board will have great satisfaction, at the close of their labors, in feeling that they have conferred the greatest benefit on commerce by making a complete revolution in the present disorganized system of light-houses.

There is at the present moment two million eight hundred thousand dollars invested in steamships alone, which pass Cape Hatteras light twice a month, all of which vessels run for the light and pass Hatteras shoals close aboard. This amount of property is invested in twelve steamships of the first class—four Charleston and Savannah ships, four New Orleans ships, and four for Chagres; eight of these vessels take the inshore route, passing all the lights as far as Charleston or Savannah, and thence proceeding to New Orleans, keeping the coast on board as far as Carysfort reef and Tortugas. I will proceed to give you an account of the lights, commencing at Sandy Hook, and follow them down to Cape Florida, the last light we see on our route. As the Sandy Hook light and beacons are intended principally as a guide up the bay, I consider them as well kept, and I have always seen them showing a clear bright light; I think they compare favorably with any harbor lights that I have seen in foreign countries.

The Navesink fixed and revolving lights I consider the only perfect lights on our coast, not only as regards regularity in lighting, but in the brilliancy of the light. The revolving light can be seen at a distance of twenty-five miles in ordinary weather, and about thirty in clear winter weather, from the top of our wheel-house, which is thirty-two feet above the level of the sea. The revolving light is seen by us, when running at the rate of thirteen miles an hour, about twenty minutes before the fixed light; whether this is to be accounted for by the greater intensity of the former, or some peculiar property of a revolving light, I don't know, but I am disposed to think that a revolving light can be seen much farther than a fixed light, both lights being equal. The Navesink light compares favorably with the revolving light at Havana, which is not so elevated as Navesink, but can be seen twenty-five miles from our wheel-houses, and also with the English light on Gunkey, which can be seen twenty miles. These two are the best lights that I am acquainted with, and the mariner can steer for them with perfect confidence, knowing that they will always be lighted in time, and even in thick weather will warn him of his danger.

The first in order on our coast is Barnegat light, much improved of late years by the substitution of the large reflectors in place of the small ones formerly in use; yet it is a dull light, and when the weather is at all hazy, (as in Indian summer,) the light cannot be discerned, or if seen, it is impossible to tell whether it is a ship's light or a light-house. I have often been deceived in this respect, and am of the opinion that a flashing light would be a great improvement on the present plan. The Barnegat light can be seen about ten miles off shore in clear weather, and, as far as I know, is regularly lighted.

The next is Little Egg Harbor light, a dim, insignificant affair, with a light sufficient to entice vessels to run for it, and in thick weather decoy them on the shoals, which run out three miles. I have passed it often within ten miles and have never seen it; and when seen, it could only be distinguished from a ship's light by its steadiness. An intense fixed light at Egg Harbor,

and a flashing light at Barnegat, would be a great assistance to vessels, and would save many from shipwreck. The distance between them is only eighteen miles, and if properly lighted they should both be seen at once coming from the south. I know nothing of the lights on Capes Henlopen, May, and Henry, and will proceed to speak of Hatteras light, the most important on our coast, and, without doubt, the *worst* light in the world. Cape Hatteras is the point made by all vessels going to the south, and also coming from that direction; the current of the Gulf-stream runs so close to the outer point of the shoals, that vessels double as close round the breakers as possible, to avoid its influence. The only guide they have is the light, to tell them when up with the shoals; but I have always had so little confidence in it, that I have been guided by the lead, without the use of which, in fact, no vessel should pass Hatteras. The first nine trips I made I never saw Hatteras light at all, though frequently passing in sight of the breakers; and when I did see it, I could not tell it from a steamer's light, excepting that the steamer's lights are much brighter. It has improved much latterly, but is still a wretched light. It is all-important that Hatteras should be provided with a *revolving* light of great intensity, and the light to be raised fifteen feet higher than at present.

Twenty-four steamships' lights of great brilliancy pass this point in one month—nearly at the rate of one every night, (they all pass at night;) and it can be seen how easily a vessel may be deceived by taking a steamer's light for a light on shore.

There is very much required off the point of Hatteras shoal a fog-bell that can be heard at some distance. I have no doubt that a buoy could be so fixed, that it would stand the heaviest gales. It would be a great guide to vessels in foggy weather, which continues, more or less, throughout the year. There are fog-bells located in the English channel, where they are quite as much exposed as one would be at Hatteras.

Cape Lookout light, elevated a hundred feet above the level of the sea, is a most important one. Blunt's Coast Pilot says that it can be seen sixteen or eighteen miles; which is not the case, as I always pass it at night, ten and a half miles off, (shaving the outer shoal,) and it is only in very clear weather that it can be discerned. Towards morning, particularly, it is difficult to be seen, owing, it is thought, to the mist which hangs over the land; but I rather attribute it to neglect on the part of the keeper, in not rubbing off the reflectors during the night. Cape Lookout shoal runs off S. by E. $\frac{1}{2}$ E. ten miles, and a vessel will only clear the end of it in seven fathoms water. I have found myself two or three times inside the shoal, looking for the light, and have been obliged to haul out without seeing it. The Double-Headed Shot Key light, (English,) though almost always surrounded by mist, can be seen at most times at a distance of eighteen miles. It is furnished with the French lens, which gives a much more intense light than the ordinary reflector; and though a light of almost the same order as that on Cape Lookout, can be seen much farther. The rays of light seem to pierce through the mist, which is not the case with Lookout.

Cape Fear, a hundred and ten feet above the level of the sea, I have never seen, though I pass two miles outside of Frying Pan shoal. This shoal extends sixteen and a half miles, according to the charts, in a SSE. direction; but by good and frequent observations I find that it extends nearly three miles farther out than it is represented; consequently, it would

require a light to be seen twenty miles to be of any service. Vessels running close along the shore always make New Inlet light, which is seven miles to the northward and eastward of Cape Fear light-house; and the latter can be of little use in enabling vessels to run around the shoal. I am of opinion that a flashing light of great intensity would (if raised twelve feet higher) be seen plainly outside of the shoal. At present, the lead is the only safe guide. A fog-buoy, with a heavy bell, should also be placed on the point of Frying Pan shoal, which forms a half-moon. It would be protected from southerly, east, and southwest winds by the shoal, and from northerly winds by the land; without doubt it would stay there forever, if properly looked after.

Cape Romain shoal extends six and a half miles south, (the extreme end,) and the light is a very good one. Towards morning it grows dim, either owing to the mists, or for want of attention to trimming—likely the latter. At ten miles it shows very fair, though it might be improved, and is not so good a light as the one on the Double-Headed Shot Key (English.) It is intended to be distinguished by red and bright lights, but I should never distinguish the difference of the lights.

Charleston light is a very good one, (revolving,) and shows from aloft at a distance of eighteen miles, which is sufficient for all purposes of navigation. It is kept in good order, but is extinguished sometimes before daylight. The beacon is a poor one, and if it is at all hazy, cannot be seen. Vessels have great difficulty in getting into Charleston, owing to the fogs. I have frequently been obliged to feel my way in with the lead, which cannot always be depended upon, unless a person is very familiar with the soundings; and these are so much alike off the bar, and to the southward and westward, that a vessel might easily run by, and bring up on the shoals of South Edisto. We generally are guided in by the steam-whistle of a ~~ma~~ steamer anchored off the bar, which we can hear at the distance of six miles. This has suggested to me the idea of having a small locomotive boiler at the light-house, with a noisy whistle attached to it, and then no vessel could possibly mistake the port of Charleston. The fogs exist at this point nearly all the year round, and during the Indian summer the land can scarcely be distinguished five miles off.

To the southward and westward of Charleston is the South Edisto light-boat, placed entirely too close in, (I struck on a shoal, eighteen months since, with the light-boat bearing north by west, eleven miles distant, no such shoal being marked on the chart;) and at night the light-boat cannot be seen over six miles at the best of times, which would render it useless for preventing vessels touching on the above shoal. It is only serviceable for coasting-vessels and small steamers.

The light-boat on Martin's Industry (a most dangerous shoal) scarcely deserves the name; it is neither useful by day nor by night. On the contrary, vessels are induced to run, knowing there is a light-boat there, and often get into difficulty. At night it looks very much like a farthing candle, and can be distinguished plainly only at the distance of three miles. I have passed it often at night and have never put any faith in it, preferring to run a little out of my course and be guided afterwards by the Tybee light off Savannah. In fogs it is perfectly useless, as it has no proper bell attached to it; or if it has one, it is not used. A light-boat at this point should also be provided with a steam-whistle, as all the steamers shave the shoals very close. There is no difficulty in keeping a vessel at her moor-

ings off Martin's Industry, as the weather throughout the year is almost always mild, and the holding-ground is extremely good.

The Tybee light, though a very good one, cannot be distinguished in foggy weather, like the Charleston light; the latter flashes through the fog in a brilliant manner, while the former shows indistinctly in hazy weather, showing the superiority of revolving lights over fixed. In clear weather Tybee shows at a distance of twelve miles, which is quite sufficient, as the water is bold up to the bar, and the light and beacon show plainly before you reach the outer buoy. Tybee light should also be provided with a steam-whistle, or there should be a bell-buoy on the bar, which is about four miles from the light-house.

After leaving Savannah our course is south until up with Cape Canaveral shoals. I know nothing of lights along the coast, as I never see them.

The next light we fall in with, after leaving Savannah, is Cape Canaveral; it is a good revolving light; is kept in good order, and shows eighteen miles from the mast-head. Since the discovery of numerous shoals off Cape Canaveral, vessels do not run so much for the light as formerly, but go around the shoals instead of between them. The outer shoal is about twelve miles to the northward and eastward of the light-house, and at night the light shows plain enough to warn vessels that it is time to haul off shore. After clearing Cape Canaveral shoals the current begins to take effect on the port-bow of a steamer and cuts her in-shore, and it is impossible to tell how much, as it varies so much with different winds. To avoid these currents as much as possible, it is necessary to steer a S. $\frac{1}{2}$ W. course, which brings a vessel up with Indian river. Here, formerly, the quartermaster of the army had a small light erected, and we found it of much service; but lately it has been removed, and the loss of it is sensibly felt. After coming up with Indian river, it becomes necessary to haul out SSE. to avoid the shoals off Point Jupiter, in latitude 27° , nearly. I believe I was the first to discover these shoals, having touched on one in the night; and Lieutenant Rodgers, of the coast-survey, having been notified of the fact, he has, I understand, made an examination and found others of a dangerous character. As this has now become the route for steamers, there is an absolute necessity for a light-house on Point Jupiter, in latitude $27^{\circ} 15'$. This is nearly the point where vessels are surrounded by shoals, the number and extent of which are not known; and when the nights are dark and no observations of the stars can be obtained, it renders the safety of the vessel a very doubtful matter; the lead is scarcely a guide, as there are few soundings, and those not to be depended upon. It would, also, be of service to vessels bound down the Gulf, to take a fresh departure from, as they often come down the stream past Carysfort reef without seeing anything. To the steamers (of which six are bound south every month) it is almost indispensable, and I only wonder that some calamity has not happened to some of them before this time.

Cape Florida light is a beacon for all persons to avoid; it is on a par with Cape Hatteras light—badly lighted, and badly kept; though one of the most important on the coast. Only four months since, I saw a vessel ashore six miles to the southward of it, no doubt having been deceived by the light, which I do not think can be seen eight miles. This light should be so arranged as to be seen twenty miles, in all directions. The English light on Gunkey, right opposite to it, (a revolving light,) shows brilliantly at twenty miles. When the light on Carysfort reef is finished, and Cape Florida

properly lighted, no vessel can possibly get on shore with ordinary care. I would respectfully call the attention of the board to the Gunkey light, by far the best light I ever saw. Long before the light itself shows above the horizon, the reflection and rays show very plainly. I do not know how the apparatus is arranged, but it is well worthy of imitation, like all the English lights. On the reef near Cape Largo is the floating light-ship, showing two lights, intended to be seen twelve miles, but they are scarcely discernable from the outer edge of Carysfort reef, which is from four to five miles distant. On two occasions I have passed it at night, when the lights were either very dim or not lighted; and I am informed that a brisk trade in oil is carried on with the wreckers on the reef. After Carysfort light is finished, there will no longer be a light-boat required at this point. Five vessels have gone ashore on and about Carysfort reef since I have been running this route, all of them a total loss, and no doubt all of them deceived by the light-boat, and sailing-directions, which inform the mariner that the lights can be seen twelve miles. I have no further knowledge of the lights on Florida reef, to the westward, as I leave the reef at Carysfort and steer for the Moro light, which we run for with great confidence, knowing that it is always in perfect order. I must do the Spanish authorities the justice to say that they pay great attention to the subject of light-houses, and all of their lights are of the very first order. They have lately established a light on Cape Antonio, with French lenses, and flashing, which is in no way inferior to the Moro light, and though only 90 feet high, can be seen plainly at eighteen miles.

The lights at the mouth of the Mississippi are very fair, and can be seen plainly twelve miles. The light at Southwest Pass has settled, and has now an inclination to the northward; consequently, the rays are thrown up four or five degrees above the horizon, and it does not show so plainly as the others. There is very much needed a bell-buoy at the South Pass, which is the middle point, and which all vessels make in approaching the Mississippi. Five months in the year there is a constant fog prevailing there, and without some such guide as a fog-bell, vessels are carried by the current many miles away from the river.

The lights I have herein mentioned are the only ones I know anything about. My recollections of foreign lights (excepting those I have alluded to) are too indistinct to permit me to say anything on the subject. I would respectfully call the attention of the board to that part of the Florida reef west of Carysfort. A large portion of our commerce passes daily along the coast, with scarcely anything to guide it; and now that our steam navigation is so rapidly increasing, and steamers have to run close, and in all weathers, I would recommend lights to be placed on the following points: on Carysfort reef, a revolving light; New Matacumbe, a fixed light; Sombrero keys, a fixed red light; and Sambres, a double light. This would give 32 miles between Carysfort and New Matacumbe; 32 miles between New Matacumbe and Sombrero keys; 29 miles between Sombrero and Sambres; and 16 miles from Sambres to the Sand key revolving light opposite Key West. Thirty miles from Sand key, (west,) the Florida reef ends, and this point should be designated by a light-boat, with two good lights, one bright and the other red; and she could lie snugly at her moorings in northwest gales, (under the lee of Boca Grande bank,) in six fathoms water; from thence the coast is clear up to Tortugas, which is already provided with a good fixed light. The above mentioned light-

houses could light up the entire Florida reef, nearly as well as Long Island sound is now lighted, and the lights would be so distinctly marked that no one could possibly mistake them. It may appear to be a large number of lights for so short a distance, but fewer would answer no purpose at all: the object being to enable a vessel to get sight of a light a short time after leaving a known one, and before the current can have taken full effect upon her. No man can know the currents of the Gulf-stream, no matter how often he may have sailed there; consequently the necessity of having in sight some constant object.

The expenditure for these lights would be small in comparison with the amount of property wrecked every year; and as the object of the lights is to benefit commerce, the expenditure ought not to be taken into consideration. No part of the coast of the United States is so badly lighted as the Florida reef. In a distance of 220 miles there are but three light-houses, while from Sapelo island to Cape Canaveral (on the coast of Georgia and Florida) there are no less than seven lights; on a coast, too, where the bottom is perfectly clear and no perceptible currents, and in a distance of 180 miles. I have nothing further to add in this communication, except to recommend that the commander of every steamship should be furnished with monthly forms, in which he shall insert the condition of each light he passes on his voyage; such report to be sent, at the termination of the voyage, to the superintendent of light-houses. This would insure watchfulness on the part of the keepers.

I am, very respectfully, your obedient servant,

DAVID D. PORTER,

Lieutenant United States Navy.

THORNTON A. JENKINS,

Lieut. U. S. Navy and Secretary to the Light-house Board.

B—No. 4.

Letter from Lieutenant H. J. Hartstene, United States navy, commanding United States mail-steamer Illinois.

NEW YORK, July 18, 1851.

DEAR SIR: In reply to your queries, concerning light-houses, I am unable to give much information, as I have been running pretty much all the time between New Orleans and Chagres, via Havana; between those places I have made monthly trips, making the Moro, Cape Antonio, and S. W. and S. Pass lights, at the mouths of the Mississippi. The two first named are excellent flash lights, and may be seen twenty miles; the two latter are much inferior, as also are all the lights on our coast, that I have seen, except those at the Highlands, which I presume are the best we have. The lights on Hatteras, Lookout, Canaveral, and Cape Florida, if not improved, had better be dispensed with, as the navigator is apt to run ashore looking for them.

A light is much required at the entrance of Navy bay, near Chagres; and if within your province, as I think it should be, I would recommend it to your consideration.

Yours, &c.,

H. J. HARTSTENE.

Lieut. THORNTON A. JENKINS,

Secretary to Light-house Board, Washington, D. C.

B—No. 5.

Letter from Captain W. Rollins, commanding the United States mail-steamer Isabel.

CHARLESTON, July 29, 1851.

DEAR SIR: I have received your letter, and shall give you all the information in my power to facilitate your noble work. First, I make twenty voyages per year to Havana, from Charleston, stopping at Tybee light, Savannah, forty times per year, and at Key West the same number of times. Those lights compare with the best of this country, but are not equal to the Moro light, at Havana.

The light at Charleston is very bad, and likewise the bug-lights for ranges about that bar, as it is seldom that the bug-lights can be seen five miles off. The main light revolves too slow, and its brilliancy is very poor. The light on Cape Canaveral is good, and revolves in good time. Cape Florida is not as good as Key West or Canaveral. The light-ship, inside Carysfort reef, is a poor thing—cannot depend on it at all; likewise the light-ship at Sand Key reef. These are the only lights I make use of in my passages, except the Moro light, Havana, which is the best light of all that I have mentioned. Allow me to suggest—what would be of much service to the merchant service, in navigating the Gulf-stream of Florida, and the New Orleans trade—to have a light put on Elbow reef, off Carysfort, 30 miles S. W. of the one now building on that dangerous reef; one 45 miles WSW. from the latter, on the Sambo keys; and then, after leaving that out of sight, the one on Sand Key will be seen, if good. This will make the navigation of the Florida reef safe, even in bad weather.

There is one other place on my route in which a light would be of much service in bad weather—that is, at Jupiter inlet, lat. 27° N. The flats north of that point are very bad, and vessels running down shore, inside the Gulf-stream, are dangerously exposed.

I would suggest a large buoy on the outer shoal of Canaveral, similar to the one on Savannah bar, SW. by S., 17 miles from the light-house, in 13 feet water. I pass close to this shoal every voyage, and at times cannot see any land, often during squally weather.

Respectfully yours, &c., &c.,

WM. ROLLINS.

THORNTON A. JENKINS,

Lieutenant U. S. Navy, Secretary to Light-house Board.

B—No. 6.

Letter from Captain Thomas S. Budd, commander of the United States mail steamship Union.

STEAMSHIP UNION, NEW ORLEANS, July 24, 1851.

SIR: By some means, your communication of May 29 did not come to hand until my arrival at New York, the last trip; to which I now reply, and only regret not being able to give you more full information on the

subject of light-houses and other aids to the navigation of the United States.

In reply to your several queries, I will state that the "Union," under my command, makes eleven voyages per year between this city and New York.

On our passage from New York to New Orleans we make Cape Hatteras light, which is not high enough, and by far too dim to be seen outside the shoals in hazy weather; the next light we make is St. Augustine, a very poor one; the next is Cape Canaveral, very good, (for an American light,) and can be seen in clear weather outside the shoals; the next is Cape Florida, about as good as Cape Canaveral; then, in passing along the Florida reefs we sometimes see the floating light inside of Carysfort reef: she shows two miserable lights, and does more harm than good, for the lights cannot be seen outside the reef unless the weather is very clear. The next light we make is Sand Key, then Key West—both of them need improving; then the Tortugas light, very poor indeed—it is unsafe to run for it unless the weather is very clear; the next are the lights about the passes of the Mississippi—the one at South Pass is the best, the others are miserable.

On our return passage we make the Tortugas and Key West, (lights already mentioned,) keep midway in the Gulf-stream, make Hatteras and Barnegat, (poor lights,) then the Highland lights, (the best on our route,) then the Hook and light-ship, (both pretty good.)

As regards the comparative brilliancy, &c., &c., between the lights on our coast and those of foreign coasts, I am sorry to say that ours cannot be compared with those of the West Indies, France, or England. The light on the Moro, at Havana, those on the Double-Headed Shot Key, and on Gunkey, are first-rate, and can be made even in thick weather; while, on our side, no one should attempt to see them, unless in very clear weather.

I regret not being able to inform you as to the apparatus, kind of oil or gas, used by the English; but certainly their lights are very superior to any I have ever seen; and their whole coast is so well provided with them, that even a stranger prefers the night to run up the channels, which are lighted up at sunset, and allowed to remain so until sunrise.

As a general rule—our lights are lighted too late, and give a poorer light towards daylight, and often are not allowed to burn until the sun rises.

Our system of beacons and buoys, compared with that of England, is very defective. We have too few buoys, and they are not properly painted and *numbered*.

The harbors of England have black can-buoys on the larboard side of the channel, and red can-buoys on the starboard side; all numbered from one to as many as may be necessary, and so near as to be seen from one to the other.

In conclusion, I have noticed the building of an iron light-house on Carysfort reef, and would respectfully suggest that every fifty miles from that light to Sand Key there be erected similar iron light-houses, so that ships may run along the dangerous reefs of Florida with safety.

I am, respectfully, your obedient servant,

THOMAS S. BUDD.

Lieut. THORNTON A. JENKINS,

United States Navy, Secretary to Light-house Board.

B—No. 7.

Letter from Captain James Miller, formerly commanding the ship Crusader, of Boston.

Boston, August 8, 1851.

GENTLEMEN: In answer to your solicitations regarding light-houses, buoys, beacons, and sea-marks on our coast, in comparison with those of other countries, I can say but little, as my voyages have been for these last eight years to China and Valparaiso, thereby restricting my opportunities for judgment of such matters very much, as we see no lights or buoys from the time of leaving until our return, with one exception—that is, the light at Valparaiso, which does not deserve the name of a light. Boston light I should say is excelled by none, considering its position, which is too low; aided much by the light on Minot's ledge, which was of the greatest benefit to returning mariners in running for Boston harbor.

A light-ship on the New South shoal of Nantucket would be of the greatest benefit to vessels navigating to and from Boston, as well as to those from Europe bound to New York.

I am, gentlemen, your most obedient servant,

JAMES MILLER.

To the LIGHT-HOUSE BOARD,
Washington City, D. C.

B—No. 8.

Letter from Captain Enoch Turley, commander of the Packet-ship Tuscarora.

PHILADELPHIA, August 23, 1851.

DEAR SIR: I embrace the earliest opportunity, since my arrival at this port, to reply to your inquiries of May 29.

I make three voyages or six passages to and from Liverpool in a year. Outward I run for Cape Clear light, which is revolving and brilliant, seen thirty miles; Old Head of Kinsale—steady, first-class—seen twenty-five miles; Saltees light-ship, two lights—ten miles. Tuskar revolves every two minutes—shows two sides bright, one red; the light of the first magnitude; the mark for entering St. George's channel; the most important light on the coast of Ireland for vessels bound up or down channel. Holyhead light, of the first class and great brilliancy, revolves every two minutes, and is seen thirty miles; Skerries, steady light, eighteen miles; Point Linas, flash, twenty miles. The above-named lights are situated upon headlands; Tuskar and Skerries on rocks, at the turning-points of the channel.

Homeward, we run for the lights mentioned; and, on our own coast, for the light-ship on Five-fathom bank, and Cape Henlopen light. The lights on the coast of Great Britain are certain to be lighted from sunset to sunrise; and if we run for a light-ship, day or night, we are *sure* to find it, as there are *always* extra moorings on board, and duplicate light-vessels kept ready to take the place of others. The lights on our coast will bear no compar-

ison to those of Great Britain or France. The Highland lights of New York are of the first order, equal to those of any other country; the only good lights, to my knowledge, between New Orleans and New York. There is not distinction enough in the lights about the Delaware; many serious losses have occurred in consequence of the lights on Cape Henlopen having been mistaken for that on Five-fathom bank, both being of the poorest. Ships with and without pilots have been run on shore to the south of the cape, in consequence. By reference to the chart you will see that the depth of water is no guide. The packet-ship *Walter*, from Liverpool, (with a pilot) was a total loss. The packet-ship *Tuscarora*, of 1300 tons, under my command, was stranded from the same cause. The wind was ENE., night hazy, not thick; light was made bearing NW. (thirteen fathoms water) supposed, and from all appearances fully believed to be the light-ship; blue-lights were burnt for a pilot; none appearing, after two hours and a half lying to, say half-past 12 a. m., I bore up to run for the main light; in one hour the ship was in the breakers, land faintly seen across Rehoboth bay. The ship remained on the beach the entire winter; the loss was immense.

We place no confidence in finding the light-ship after a winter passage. The boat on Five-fathom bank broke her moorings about eight years ago, and was six weeks, to my knowledge, in Cape May roads until her moorings could be found, she having no duplicates on board. The ship, then under my charge, with a pilot on board, was in four fathoms water, drawing eighteen feet. This light has been removed this summer, with but a few days' notice; and several vessels have been near getting into difficulty in consequence. The position is one of the greatest importance, both for this port and New York, as all the southern trade for the latter port, especially in winter, run for her, particularly steamers.

Our system of buoys and beacons will not compare with that of Great Britain. It is a rule established by the Trinity board all over the kingdom, that all red buoys must be kept on the starboard hand, and black on the larboard. All persons running into ports by stress of weather, making buoys, know by the color which way to steer. They use can and bell-buoys; the bell is struck by the motion of the sea—of the greatest importance in the night or fog. †

Respectfully,

ENOCH TURLEY.

To Lieut. THORNTON A. JENKINS, U. S. N.,
Secretary Light-house Board, Washington, D. C.

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B—No. 9.

Letter from Captain R. M. Dunlevy, commander of the packet-ship Wyoming.

PHILADELPHIA, August 28, 1851.

DEAR SIR: Yours of the 29th May, I received on my late arrival from Liverpool; and it affords me pleasure to give you what little information I possess, hoping that it may have some influence in the protection of our commerce.

I make three voyages or six passages annually to and from Liverpool. The lights on the British coast, on the most important and prominent points, are of the first class, and of great power of reflection and brilliancy. Cape Clear, a revolving bright light, shows great brilliancy once in every two minutes. I have seen it distinctly 30 miles off. The next light, proceeding, is Kinsale, a fixed brilliant light; I have seen it 24 miles off; the Saltees light-ship, showing two lights, I have seen distinctly 12 miles off; Tuskar, revolving light first-class, shows two bright lights (and one deep red) every two minutes; the deep red shows every six minutes; I have seen them distinctly above 30 miles off. This is the most important light in navigating the coast of Ireland to England or Scotland, it being the northern guide for St. George's channel, and the Smalls light-house being the southern guide. The Smalls light is fixed, which I have seen 16 miles. The South Stack light, (or Holyhead,) first-class revolving, of great brilliancy, I have very distinctly seen 30 miles off. On board of all the light-ships are large alarm bells, which are continually rung in thick or foggy weather. At the entrance of channels and rivers are bell-buoys, which the motion of the sea keeps constantly ringing; and painted buoys in entering the channels; the red buoys keep on the starboard and black on the larboard hand. The weather on the British coast is rainy, misty, or foggy, nine months in the year. The lights are so judiciously arranged and of such powerful reflection, that we always feel a confidence in seeing the light, or hearing the alarm-bell when approaching dangers. They have at all times, duplicate light-ships ready to be placed in position, should any accident happen to those moored near the dangers. My track being between Philadelphia and Liverpool, I cannot speak of other lights than those in the vicinity of the coast of Delaware bay. In sailing for the Delaware, I generally endeavor to make the light-ship off Five-fathom bank, (*when there*;) she shows two lights; they are not of sufficient power for that important position. It is of great importance at all times, to have a light-ship off that bank. Ships from the southward bound to New York, with northerly winds, traverse the vicinity of that dangerous bank. We cannot place any confidence, when making our coast, in seeing the light-ship, for annually she has been removed, moorings breaking, wanting repairs, or to clean paint, and no other light-ship is placed there; and when removed, there has seldom been a week's notice given. For the last three months, there has not been a light-ship or beacon near that shoal. The light-house on Cape Henlopen has a fixed light. I have never seen it more than 12 miles off in clear weather; it is a very bad light, and not of sufficient height. Cape May light is revolving; I have seen it, in very clear weather, 18 miles off. The entrance to the Delaware bay is the most difficult and dangerous one along our coast; we have no southern guide—the soundings change so much that we can place no confidence in them. There should be a good light-ship moored off Fenwick's Island shoal, with one bright or deep-red light. Cape Henlopen light should be first-class revolving; Cape May light fixed; the light-ship on Five-fathom bank, two lights. By looking at the chart of Delaware bay, you will see the Overfall, a very dangerous ridge extending out from Cape May, two-thirds the distance across the bay. There should be on the southwest part of the Overfalls a bell-buoy, which would be of great importance. Cape May light is not of so much importance as the other lights I have mentioned. Vessels of large burden never go between Cape May and Five-fathom bank. I would most strongly recom-

mend a light-ship on Fenwick's Island shoal ; it would be of great importance to navigators, as many vessels, large and small, have been totally lost between Cape Henlopen and Fenwick's island, which might have been saved had there been a light-ship off Fenwick's Island shoal.

Our lights bear no comparison with foreign ones.

Very respectfully, your most obedient servant,

RICHARD M. DUNLEVY.

THORNTON A. JENKINS,

Lieutenant U. S. N., Secretary to Light-house Board.

B—No. 10.

Letter from Captain George Barker, commanding a freight vessel from the port of Boston.

BOSTON, August 29, 1851.

GENTLEMEN : I received your communication under date of May 29th since my return from sea, August 25, and in reply will most cheerfully give you what little information I possess, as well as experience on our coast. In answer to the first inquiry : I am now, and have been since 1840, engaged in the freighting business between the Gulf of Mexico and Europe, (say Liverpool and France,) making two and three voyages yearly. From 1832 to 1840 I commanded a packet-ship between Boston and New Orleans. The navigation from the Gulf of Mexico through the Gulf of Florida, is very intricate and dangerous. Our first point from the Gulf of Mexico is the Dry Tortugas, on which is a fixed light, but not of sufficient brilliancy and power to be seen over ten miles in very clear weather ; then we shape our course through the Gulf. The Tortugas being the extreme point of the Florida reef, it is of the greatest importance that the light should be of the first magnitude. (It is much better since the alteration by Mr. Lewis, but is not what it should be, now.) The next point is Key West ; the new light is very good—can be seen fifteen miles. The light-boat placed near Sand Key (on which a light-house is in course of erection) cannot be seen three miles, consequently is of no use to the mariner ; it is moored inside of the reef, and is no guide to the navigation of the reef. A good light-house on the outer Carysfort reef is of the utmost importance, to enable the mariner to know his position in rounding the west coast of Florida—the whole coast of which, at the present time, is very deficient in lights, beacons, and buoys.

Foreign lights.—The English and Irish lights far surpass ours in brilliancy and distinction. The navigation of the English and Irish channels I consider safer in winter than in summer, as regards knowing your position. The lights are so well distinguished, and so brilliant, that many of them are seen thirty miles. I consider the English lights superior in brilliancy and power to the lights on our coast. The general character of our lights on seaboard : the position (as far as my experience goes) is good ; but (with a few exceptions) they are not of sufficient power to be seen, upon an average, for more than 10 to 12 miles in clear weather ; and our coast being subject to fogs and hazy weather, the lights require to be more powerful than in an even climate.

The lights on the northwest coast of France are superior to our lights in brilliancy and power; they are fitted with powerful glass "lenses," which add much to the power. Another great advantage is the *strict attention that is paid to keeping them clean and in perfect order*. Those that I have visited in France, in the English channel, are kept in perfect order, which adds much to the brilliancy and power of the light.

I consider Boston light, (outer light,) Nantucket, on Sankaty Head, Highlands of Navesink, at New York, as among the best lights on our sea-coast; but none of them are equal to the best English lights, or French, in the English channel, but superior to the lights in the Mediterranean, (except those belonging to the English,) also Spain, Portugal, and south of France.

Distinction.—The lights as a general thing on our coast, on the sea-board, are distinguished without difficulty—not being so numerous, are more easily distinguished than in England: there, so many lights are necessary, that in order to give them distinction they have adopted the plan of many of the revolving lights, showing different colored faces; and each distinction in the light-houses is published in a book or guide, describing the house, light, how long in revolving, fixed or flashing, so that by referring to the guide you can be sure of your position, which is very important to the mariner.

Light-vessels.—As far as my experience goes, the light-ships on our coast are very deficient, and there are only two or three on our whole coast in which I have sufficient confidence to run for in thick weather. They are too small, and are not to be depended upon.

The system of buoys, beacons, and sea-marks, will not compare with that of England; and some parts of the coast, especially the Florida reefs and coast, are sadly deficient in buoys, beacons, and sea-marks, as well as lights. Those lights erected by the English government on the Great Bahamas and vicinity, are to be seen much farther, and more dependence placed upon them, than our lights in that neighborhood.

The navigation of the Gulf-stream has increased one-half during the past ten years, and no part of our coast is so deficient in marks to guide the mariner as along those reefs; and I am much gratified to learn that government is turning its attention to improving the facilities for navigation upon our coast, for which there is ample room.

Any information in regard to the navigation of the Gulf of Mexico and Florida, to the situation of beacons, lights, &c., &c., I will most cheerfully forward, as far as my experience has taught me.

Very respectfully, &c., &c., &c.

GEORGE BARKER.

To the LIGHT-HOUSE BOARD, *Washington City*.

B—No. 11.

Letter from Captain Wm. H. Russell, commanding packet-ship Princeton, of New York.

LIVERPOOL, *August 27, 1851.*

SIR: At the request of Mr. Manning, of New York, I addressed to you "answers" to sundry "queries" submitted by you to experienced ship-

masters, with a view to obtain every information relative to the true state or "present condition" of lights, and other aids to navigation, in the United States.

In reply to your first question, I will briefly state that I have commanded first-class freighting ships during the last eighteen years, in the European trade, chiefly to Liverpool; I have just completed my eighty-seventh passage across the Atlantic, and average seven passages per annum. To your second question I will state, that I have generally ran for Cape Clear light with northerly winds, and the Hook light at Waterford, or Tuskar light, in south-west or southerly winds. In reply to your third question, Cape Clear and Tuskar lights are each revolving, and each have the same interval of obscurity, (two minutes,) yet they are very different and *distinct* in character; rendered so by a difference in color. All the revolving lights which I have personally inspected, are furnished with a horizontal triangular arrangement of lamps, thus presenting one side of the triangle full to view every two minutes, as it revolves, which gives the greatest brilliancy, and as the points or angles of the triangle pass in its revolution, the greatest obscurity prevails. Each side of the triangle being furnished with lamps and reflectors, according to the strength of light required, and in order to give the light any color, it is only necessary to use stained glass shades of the requisite hue. Some lights revolve so as to emit the greatest brilliancy every 90, 30, 20, or 10 seconds, and some are so constructed as to be visible all the time, but having, in addition, a "flash" every ten seconds; other British lights are arranged differently, as will appear by a recent "Notice to Mariners" by their government, viz: "On and after the 1st day of June, 1851, a light will be exhibited on Mine Head, on the south coast of Ireland. Intermittent; bright fifty seconds, obscured ten seconds; seen seven leagues in clear weather." "Also on Bally Cotton island, a flashing light, bright every ten seconds, visible six leagues in clear weather."

I am most familiar with the English and Irish lights; they are as brilliant just before day as when first lighted at evening; they are, however, well attended, and trimmed at various periods, especially during the long winter nights.

To query the fourth, I would state that the general character of English and French lights is superior to our own in every respect; are more brilliant, and also more elevated—consequently can be seen much farther, probably one-third. Those lights erected at the Hole in the Wall, Gunkey, and Double-Headed Shot Key, by the British government, *are the only good lights* on the route to New Orleans, and other Gulf ports. English lights are generally elevated from 250 to 300 feet. With the exception of the lights on the Highlands of Navesink, near the entrance to New York, I do not know of any light along the entire line of our coast which will bear any comparison with those of England, or which can be ranked in the first class. Holyhead and Tuskar are the best revolving lights I know of, and the Hook light, at Waterford, the best steady or fixed light.

The lights on our coast are very inferior to those of Great Britain in their characteristic distinctions.

The light-vessels on our coast will not compare favorably with those of Great Britain, for usefulness or for certainty of position.

During the awful gale of January, 1838, when the "Pennsylvania" and several other packet-ships were stranded near Liverpool, the Northwest light-ship parted from her moorings, and was driven from her station; the only instance, within my knowledge, ever happening to British vessels,

while with us they are of very frequent occurrence. Lights of light-vessels cannot be seen far at the best, and should only be employed where permanent lights cannot be placed on terra firma. The English government are now building a light-house on Half-tide rock, at the Saltees, so as to discontinue the light-vessel now at that place, owing to its limited vision (9 miles) for want of elevation; with us they cannot be seen more than six miles.

The buoys, beacons, land and sea-marks of Great Britain are infinitely superior to ours; they are larger and much more distinct in character and form, so that they cannot be mistaken. In England everything which the wisdom and ingenuity of man can devise, has already been done to render navigation, and consequently life and property, more safe; but with us, I regret to say that almost every facility yet remains to be furnished.

Your obedient servant,

W. H. RUSSELL.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to the Light-house Board.

B—No. 12.

Letter from Captain T. A. Wotton, commander United States mail-ship Franklin.

NEW YORK, September 9, 1851.

SIR: Your communication of May 29th was received on the 24th July, two days previous to my sailing on my last voyage, and in consequence of my first officer and purser both being sick, and not on duty, I was not enabled to answer before this moment.

In steaming between the ports of New York and Havre, after leaving the Highlands and Fire island lights, we shape our course to pass as close as prudent to the South shoal of Nantucket; then steering to the north and east, passing between Sable island and the coast of Nova Scotia—provided it is not the season for ice, when we go south of the island, passing close under Newfoundland, occasionally sighting the light upon Cape Pine.

In approaching the English channel upon the circle, the light moored upon the "Seven Stones," and the revolving light upon St. Agnes, Scilly, are the first made in good weather; from thence up channel there is a chain of lights, so that by the time we drop one we make another, in clear weather, along the entire English coast. The lights are all of the first order, and visible from five to seven leagues in an ordinary atmosphere.

On the French coast, at the present time, the lights are admirable. Those of Fecamp, Cape le Heve, Barfleur, Cape le Hague, are, in my opinion, even superior to those on the English coast, with the exception, perhaps, of the light upon Start point. I have often, from the deck of an ordinary-sized ship, seen at the same time the fixed lights of Cape le Heve and the flashing light on Cape Barfleur—distance between, fifty-four nautical miles.

On our return passage, a light upon Cape Race, Newfoundland, would be of immense advantage, particularly to steamers making their passages to the United States upon the great circle; that upon Cape Race being only

important for ships entering or leaving the Gulf of St. Lawrence. Upon our own coast; the next important point is the South shoal of Nantucket, providing it be practicable possibly to moor a light in that position. The soundings in that vicinity being irregular and always shifting, consequently cannot be much depended upon. The light moored outside the "Seven Stones" to the northward of Scilly island, lies exposed to the whole force of the gales and heavy seas heaving in from the Atlantic ocean, and has remained constantly in the same place from 1840 to the present time. Again, upon Fire island I would recommend there should be placed a flashing light upon the French system, of the first order, the present one being a miserable affair, and in my opinion still more miserably attended to, as I have found its brilliancy at various times very different, with the same atmosphere.

The lights upon the Highlands of Navesink are good, and will compare favorably with the majority of the lights upon the coast of Europe.

A light upon Flynn's knoll, opposite the point of Sandy Hook, would be very useful for steamers entering the bay of New York at night. The channel between Sandy Hook and the knoll is gradually diminishing, since the closing of the Shrewsbury inlet. The waters of the Shrewsbury river formerly emptied through the inlet into the Atlantic, but are now compelled, since the closing of the inlet, to pass out between the main land and Sandy Hook, washing away the point and throwing it farther to the eastward.

The present arrangement of the buoys in New York harbor, made in May last, has made matters worse than they were before; for instance, under the former regulations the buoy on the south side of the channel, on the bar, was painted white, the north side black—the present arrangements are, on the south side black and red, and the north side black. As both present a dark appearance, it is impossible to distinguish between them in thick weather; and in fact, all the buoys up the harbor being similarly arranged, it is impossible to make out any difference between them, except you approach them closely, and have clear weather.

Having nothing further of importance to communicate, I remain

Yours, respectfully,

T. A. WOTTON.

Lieut. THORNTON A. JENKINS, U. S. N.,

Secretary to Light-house Board.

B—No. 13.

Letter from Capt. J. S. Doane, commanding packet-ship American Eagle.

WILLIAMSBURG, LONG ISLAND,

September 20, 1851.

SIR: On my return to Long Island I have received yours of May 29, and I beg to express my regret at the delay. I deem it proper to acquaint you with the fact, that for the last four years I have sailed between the ports of New York and London; the previous ten years were spent in sailing from New York to the south of the United States, and to the southern ports of Europe.

I make six passages between New York and London per annum. The

lights we run for on the English coast are the Lizards (a fixed light) and the Start Point, (a revolving light,) and can be seen in clear weather at a distance of from twenty to twenty-five miles. They are situated on high points of land, and are, in my opinion, superior in brilliancy to any lights on the coast of the United States, excepting those on the Highlands of Navesink, which lights we run for in entering New York bay.

There is more regard paid to the range of the lights on the English coast than on that of the United States. They are generally superior in brilliancy, and are better characterized. Their interior I have not yet had an opportunity of inspecting.

The light-vessels in the English channel I consider superior to any that I have seen, and are so placed as to form a sure guide under all circumstances.

I deem the system of buoys, and beacons, and sea-marks, of the United States, far inferior to that of Great Britain. Their plan of distinguishing beacons and buoys by numbers and marks, answers admirably, rendering navigation, otherwise dangerous, comparatively safe. There is no dangerous shoal that is not pointed out.

Permit me respectfully to suggest the propriety of placing a light-ship on the South Nantucket shoal, which appears to me to be practicable.

I beg to reiterate my regret at the delay in answering yours, occasioned by my absence; and I remain

Your obedient servant,

J. S. DOANE.

Lieut. THORNTON A. JENKINS, U. S. N.,

Secretary to Light-house Board.

B—No. 14.

Letter from Captain C. R. Mumford, commanding packet-ship Wisconsin.

NEW YORK, September 28, 1851.

SIR: Your favor of May 29th is before me, inquiring into the condition of the lights, &c., upon the coast of the United States, by a number of queries, to which I take great pleasure in replying.

1. The first five years of my commanding a ship was between New York, New Orleans, or Mobile, and Liverpool, returning to New York from Liverpool; average two voyages a year, or four passages. The following three years I commanded one of the New York and New Orleans packet-ships. The average number of passages in this trade was eight per annum. The next three years was the same as the five years, and in the same trade, with same average number of passages; and three out of last four years was in the direct trade between New York and Liverpool; and lately from New York to California, China, London, and back to New York in fifteen months; and the last voyage that I have made was from New York to Liverpool, and home to this port.

2. In going south to New Orleans or Mobile, the first light that I run for is Abaco, on the island of that name; after passing which, (if the ship's draught of water will admit of it,) over the Great Bahama bank; if this is not practicable, round the edge of the Bank to Gunkey light; after passing

which, down the edge of the Bank until south of Orange key; from here steer over for the Salt Key bank, and following it down to the Shot Key light; from the Shot Key light a west course by compass, with the wind prevailing at ENE., and the usual current. A ship will generally fall in with Florida reef between Love key and Key West; and from here, following the edge of the reef to the Tortugas; from the Tortugas, if the wind holds easterly, and bound to Mobile, make the land to the eastward of the light and bar; if bound to New Orleans, steer for the South Pass light.

On my return from these ports, I make the Tortugas light, (if lighted,) then the Shot Key and Gunkey lights, avoiding the Florida reef as much as possible, for want of lights and beacons. When to the northward of the Little Bahama bank, if bound to ports in the English channel, I steer for the Lizards; if bound to Liverpool, for Cape Clear light; if bound to New York, I follow the Gulf-stream to Cape Hatteras.

In the direct trade between New York and Liverpool, I always make Cape Clear or Kinsale Head light; on the return passage, after leaving Nantucket, if the wind is to the northward I endeavor to close in with the east end of Long Island; and with this wind there is a strong southerly current (say $1\frac{1}{2}$ knots) prevailing, which is the cause of our endeavoring to get hold of the Long Island shore; if the wind is southward and easterly, we run for the Highland lights.

3. The location of the French and English lights is good, with the exception of the Cape Clear light, which, from its great elevation, (455 feet,) is often hid by the fog in winter; and it has been found necessary to build a light on the Fast-net rock, elevation 151 feet. The Fast-net rock is about six miles west of Cape Clear, and when the new light is lighted, Cape Clear will be discontinued.

The new lights on Bally Cotton island and Mine Head, south coast of Ireland, are well located; and in a distance of 96 miles, from Kinsale Head to Tuskar Rock light, a ship would have a light in sight all the time, if within twenty miles of the land, and a fair night to see a light. The character of all the French and English seacoast lights stands very high, and I have never hesitated about running for them, if the night was at all fit to do so. The apparatus employed in all the new lights is the dioptric, or Fresnel, and I am not aware of the apparatus of the old lights. The Head lights are very brilliant, and the height of several of them, with their range, I copy from a late publication of the hydrographic office of the Admiralty; height is from high-water mark.

Name of light.	Height.	Distance seen.
	<i>Feet.</i>	<i>Miles.</i>
Scilly	188	16
Eddystone	72	13
Start Point	204	19
Needles	469	27
St. Catharine's	178	18
Cape Clear	455	27
Kinsale	274	22
Bally Cotton	195	19
Mine Head	285	21
Hook Tower	152	16
Tuskar Rock	101	15
Holyhead	201	19
Bardsey Island	129	17
Small's	70	13
Calf-of-Man	375—280	22
Wicklow	250—121	21—16
Arklow light-vessel	25	9
Kish	25	9

These lights are seen from two to three miles further from my ship's poop, at an elevation of twenty feet. I have never known or heard of an instance of these lights being out before their proper time, as they are closely watched from the coast guard-stations round the coast. In two instances upon our own coast I have known the lights to be out between three and five o'clock a. m. One of these was at the Dry Tortugas light, when I was within eight miles of it, and the other was at the light-ship off Carysfort reef, to which I found myself very near at day-light, with the light-ship plain in sight. There was, also, some uncertainty about Hatteras light some years ago. At one time I have seen it distinctly from the extreme edge of the shoal; at another time I have rounded the shoal in sixteen fathoms water, and could not see the light until it bore west of me.

4. The positions of most of our sea-lights are good, but in point of brilliancy and range very defective, and we are far behind the English and French in these respects.

5. The only *good* sea-coast lights that I have seen in our country are those on the Highlands of Navesink, which I think are equal to Kinsale Head light. Montauk light is of the same height as the light on the island of Abaco, which I have often seen eighteen miles; but I have never seen Montauk over fifteen miles, and I have a very unfavorable opinion of all our lights on the sea-coast south of New York and east to Nantucket; from Cape Cod to Maine, I have no knowledge of them; Cape Hatteras and the Tortugas lights are a disgrace to the country.

6. As to characteristic distinctions they compare favorably; but I think we should use more flashing lights in some points, at intervals of ten or fifteen seconds.

7. The light-vessels on the coast of the United States are very defective in model, and there is no certainty as to their position. These lights are only an apology for what they should be; and as for their range, you might *possibly* see them before running them down, if they had not drifted with or parted from their moorings.

8. I am not aware that we ever had a system for buoys, any further than

Ex.—8

the recommendation of Professor Bache; and his suggestions for all red boys, on entering a port, to be left on the starboard hand, and black on the larboard, should be adopted at all our sea-ports. This is the rule in England, and a stranger could take a vessel into their ports if he could distinguish the color of the buoys, and I am aware that the suggestions of Professor B. have been carried out in this harbor.

The beacons and sea-marks of England are much superior to ours in every respect; you could not find a shoal on the whole coast, that would bring a ship up, but what has its perch-buoy, and beacons on the land to range with it, in case the buoy should be carried away.

I would most respectfully suggest to the honorable board, the necessity for a good and powerful light-boat to be moored off the New South Shoal of Nantucket. Last February the packet-ship *Ivanhoe* was lost upon it, and seventy souls perished; of the whole ship's company and passengers, not one was saved. In June the packet-ship *J. Westervelt* was on shore, on it, for ten hours; and a few days later, the new packet-ship *Great Western* was there for the night.

It may be stated that it would be impossible for a light-ship to hold on there; and if so, I would only call your attention to the position of the *Saltees* light-boat off the island of that name, between Waterford and Tuskar rock, on the south coast of Ireland, and to the position of the light-boat off the "Seven Stones," about ten miles to the northeast of Scilly islands, at the entrance of the English channel—these vessels have never moved from their position, and they lie very much exposed to the whole sweep of the Atlantic ocean, with its heavy westerly gales in winter. Should a light-boat be placed there, as I have suggested above, I hope and trust that she may be properly moored.

Within the last few years a great number of vessels have been stranded between Montauk Point light and Fire island light, on Long Island; and in many instances there has been a great loss of life, as many of them were vessels loaded with emigrants; and I would most respectfully suggest that a powerful *flashing light* be placed on some elevated position about half-way between Montauk and Fire island lights. This last light is but a very indifferent one, and at a distance of ten miles, shows about as large as a star of the fourth or fifth magnitude.

I would also suggest that a large floating bell-buoy should also be moored between the light-ship off Sandy Hook and the bar; it would be of great service to navigation in foggy weather.

I am, very respectfully, your obedient servant,

C. R. MUMFORD.

Lieut. T. A. JENKINS,

United States Navy, Secretary to Light-houses Board.

B—No. 15.

Letter from Captain A. B. Lowber, commanding packet-ship "Star of the West."

NEW YORK, October 8, 1851.

SIR: As a member of the maritime community, I have perused with the deepest interest your recent communication, relating to light-house im-

provements, &c. The subject is so strictly practical in its character, and so important in its bearings on the commercial interests of our country, that it no doubt justly demands, on the part of government, the utmost attention it can possibly receive. I need scarcely add, that it affords me sincere pleasure to answer, as satisfactorily as I may be able, the several inquiries submitted in the above-mentioned communication.

During the last eighteen years I have regularly traded between the ports of New York and Liverpool, and the latter part of that time I have made, on an average, seven passages annually.

The lights invariably run for on approaching the channel have been Cape Clear, Old Head Kinsale, Bally Cotton, Mine Head, Hook light, Saltees light-ship, Tuskar light, Holyhead, Skerries, Point Lynas light, and the lights of Liverpool harbor.

Cape Clear light is located on Clear island—SW. extremity of island. It is very brilliant, and revolves once in two minutes; seen twenty-two miles seaward.

Old Head Kinsale, on the south point of Old Head, a bright fixed light; seen eighteen miles in clear weather.

Bally Cotton light, on the island of the same name, westward of Bally Cotton bay. It emits a bright flash once in ten seconds, or six flashes per minute; visible sixteen miles in clear weather. The lantern is 195 feet above high-sea level; tower is circular, of stone color; the projecting gallery and blocking under the arch are red.

Mine Head, a splendid intermittent light, on a bluff point of the same name, $17\frac{3}{4}$ miles E. $\frac{1}{2}$ N. from Bally Cotton light, emits its full brightness fifty seconds per minute; obscured during the remaining ten. It has been seen twenty-three miles. The lantern is 285 feet above high-water level.

Hook light, on a low point of land at the entrance of Waterford; a stationary white light of the second magnitude; seen twelve miles.

Saltees light-ship, anchored five miles SW. from Great Saltees island; shows two fixed lights; seen nine miles.

Tuskar light, on a rock of the same name, is superior to anything of the kind that I have seen in any part of the world. It emits a magnificent light, alternating white and red, revolving once in two minutes.

Holyhead light is also splendid. It is located on Holyhead island, Anglesea, and revolves once in two minutes; seen twenty miles.

Skerries light, on a rock of the same name, seven miles NE. from Holyhead. This is a bright fixed light; seen fifteen or eighteen miles.

Point Lynas light, an excellent one, on the NE. point of Anglesea, emits a bright flash every ten seconds.

The Liverpool harbor lights are all of a splendid character. They are well kept, and have good, substantial beacons on the land, ranging with the light-ships. So admirable is the arrangement in regard to the location of buoys and lights, and such the certainty of their position, that should a mariner be compelled to enter without a pilot, it could be done with much less anxiety than in any of our harbors.

Outside the bar there is moored a bell-buoy, with the course and distance to be run for the Formby light-ship, in iron letters, riveted on the iron framing supporting the bell. This buoy is moored in nine fathoms water, and is extremely useful in a fog, rendering anchorage even then perfectly easy; as, with very little motion of the water, the bell may be heard several miles.

The lights are equally good in the North channel as in the South channel.

I regret my inability to furnish a description of the apparatus employed in any of the above lights.

The lights of England and France are *invariably* lighted from sunsetting to sunrising.

On my homeward passages, in approaching our coast, I steer for the Highland lights, which, from the eastward, cannot be mistaken. I have seen nearly all the lights in the United States, and consider these by far the best. That of Cape Henlopen is greatly inferior to those of England or France, in positions of equal importance. On my last voyage from England to Philadelphia I was within five miles of this light, yet could scarcely perceive it; whereas, had it been of the same character as those in parallel localities on the English or French coast, it could have been seen at a distance of eighteen miles. Barnegat and Fire Island lights are miserable. Our light-ships, I am sorry to say, as an American, are useless. Their locality, perhaps, is as good as that of similar vessels in any other country; but, in point of certainty of position, they cannot be depended on, as can those of England or France.

On a voyage from Liverpool to Philadelphia, last summer, I inquired of some of the regular traders if the light-ship was yet on Five-fathom bank, and was answered in the affirmative. I therefore concluded it safe, on approaching the coast, to run for said ship; the wind being fair, and having had several good observations, morning, afternoon, and evening. At midnight I judged myself to be two miles south of it; but seeing no light, and fearing that the current had driven me more to the southward than I had allowed for, I thought it best to heave to till daylight.

An hour after I took a pilot, and upon inquiring how the light-ship bore, he replied that the Five-fathom bank bore north three miles, but the light-ship was not there, having been removed for the purpose of repairs.

I have also known the one at New York taken away at a very short notice.

In England, duplicate vessels of this character are kept on hand; in case, therefore, one should break adrift, another is found in the same place in less than twenty-four hours. On the erection also, or changing the positions of lights, beacons, or buoys, timely notice to this effect is hung up in all their custom-houses, and as near as possible the desks where the captain enters his ship and obtains its clearance.

The English buoys, also, are much larger than our own: iron can-buoys, and those at the entrance of their harbors, in all their principal ports, are painted red on the starboard and black on the port-hand, which is found to be a most admirable arrangement.

Our lights, as to brilliancy and certainty of being lighted from sunsetting to sunrising, and our light-vessels, as has already been remarked, in point of brilliancy and certainty of position, as also our buoys and sea-marks, will not compare with those of England or France.

Permit me to make a few remarks by way of suggestions, which I trust will meet your approbation. A light-vessel near Nantucket shoals would be as great a benefit, perhaps, as our government could confer on its maritime commerce. Nor would it be more difficult, probably, to keep one there than off New York harbor, or on Five-fathom bank, off Delaware bay.

I also think that three beacons, at least, on Long island, between Mon-

tauk point and Fire island, would be of great use, by enabling the mariner to define his position, which could not possibly be done by the aid of his lead alone, in the absence of sun, moon, and stars.

The light-ship off the Hook is quite useless, as it is not difficult for a vessel to run almost over it ere its lights can be distinguished.

A bell-buoy, also, in the place of the white one moored at present off the bar, at the entrance of New York harbor, would be another invaluable advantage.

In conclusion, permit me, most respectfully, to suggest that ere the lights on the United States coast, with the exception of those on the highlands, can at all compare in point of brilliancy with those of England or France, a very material change will be necessary. If our government will but afford the mariner the same character of lights throughout our coast as those of the highlands, and give Neptune a chance to sound in his ear a bell-buoy, in a few special localities, and let our iron can-buoys stand up from the surface as do those of England and France, the result would no doubt be the saving of many valuable lives.

Yours respectfully,

A. B. LOWBER.

THORNTON A. JENKINS, Esq.,

Lieutenant United States Navy, Secretary Light-house Board.

B—No. 16.

Letter from Captain H. Knight, commanding packet-ship "New World."

NEW YORK, October 13, 1851.

SIR : I will, in answer to your queries in relation to light-houses, buoys, &c., &c., take them up in the order in which they are proposed and briefly give you my opinion on each.

1. I make three voyages per year, between New York and Liverpool.

2. In going out I run for Cape Clear, Old Head of Kinsale, Bally Cotton, Mine Head, Hook light, at Waterford, Saltees light-ship, Tuskar, Bardsey, Holyhead, Skerries, Point Lynas, and the light-ships off Liverpool.

3. With the exception of the light on Cape Clear, (which is now being removed to a much better position on Fastnet rock,) these lights are all admirably located; and nearly all of them are on the Fresnel system. For brilliancy, range, steadiness, and certainty of being lighted, they have no superior in any country which I have visited.

4. As a whole, they are *very much* superior to those lights on our coast in positions of equal importance, in brilliancy and range, and, consequently, in usefulness. The only light on our coast which will compare at all favorably with the most of those I have mentioned, is the revolving light on the Highlands of Navesink.

5. With the single exception above mentioned, we have no lights that I have seen, which will compare with Cape Clear, Mine Head, Bally Cotton, Tuskar, Holyhead, and Lynas, in the Irish channel, or with the Lizard, Eddystone, Start Point, St. Catharine, Dungenness, Calais, Cape La Heve, Barfleur, Cape La Hague, and Ushant, in the English channel.

6. As far as I know, our light-houses are located well enough, and their characteristic distinctions clearly enough defined ; but they lack brilliancy.

7. I think that our light-ships are decidedly inferior to those in either the Irish or English channels ; I mean in regard to the character of the lights shown, and the certainty of finding them in their positions. Our light-ships are frequently withdrawn from their stations for repairs, at very short notices, and no vessels are provided to take their places while they are withdrawn. In England, duplicate vessels are kept in readiness to replace immediately any vessel which may get adrift from her moorings, or needing repairs. The lights shown by light-ships in the vicinity of New York are much inferior to those shown in the Irish and English channels.

8. The system of painting buoys, as adopted in this country in May last, corresponds very nearly to that in use in England. There, however, every buoy is numbered with large figures, on at least three sides ; and when there are more than one channel, leading across the bar of any place, or into the harbor, each buoy is marked with the first letter of the name of the channel to which it belongs. The marks and numbers read as follows : 5—V, meaning that the buoy marked thus is number 5, belonging to Victoria channel.

In hazy weather, when the landmarks are obscured, the mark and number of a buoy will instantly tell a pilot of his position. The iron can-buoys in New York harbor are very much inferior to those on the English coast ; they are not high enough out of water, and cannot be seen but for a very short distance, especially when there is much sea running.

I cannot too strongly urge the importance of having a large buoy, similar to the bell-buoy at the entrance of Liverpool harbor, placed on or near the bar at the entrance of New York harbor. Such a buoy would often prevent vessels being obliged to lay off and on, or come to anchor outside of the bar when bound in, in hazy weather, or coming to anchor in the Horse-shoe when bound out. I have always found that pilots have great difficulty in seeing the buoys at present on the bar when it is at all hazy. This would be much more easily seen than a common buoy, and the sound of the bell would materially assist pilots and masters of vessels in finding it in hazy weather.

I would also suggest the propriety of having two or three beacons placed on Long Island, between Montauk Point and Fire island lights. These would be of great assistance to masters of vessels bound to New York from the eastward, when they are at all doubtful of their position. I am very glad that our government has appointed a commission to examine into the condition of our light-houses, buoys, &c., and to collect information from ship-masters and others, as to the comparative merits of our system compared with that of other countries. As an American, I am sorry that we make so poor a show in such an important matter, and one which is so apparent to every one who has seen the lights on the other side of the Atlantic.

When last in Liverpool I conversed with several of our oldest and most experienced ship-masters, on the subject of lights and buoys, and in the opinions above expressed they all substantially agreed.

Respectfully yours,

H. KNIGHT.

Lieut. THORNTON A. JENKINS, U. S. N.,

Secretary to the Light-house Board, Washington, D. C.

B—No. 17.

Letter from Captain R. B. Forbes, of Boston, Mass.

MILTON, November 5, 1851.

SIR: Being confined to my room by lameness, I have only this moment received your favor of the 1st, accompanied by a circular of May 29th, and a printed copy of the act of Congress relating to light-houses, approved March 3, 1851.

I must premise what I have to say on the subject by informing you that I have been absent from the United States from June, 1849, to July, 1851; hence the reason I did not receive your first communication. I have also to say that I abandoned going to sea, as a profession, in 1830, and have only been on voyages of pleasure, as commander and as passenger, since that date, and previously always to China, so that my opportunities of comparing our light-house system with others have been small, and I do not, therefore, imagine that I can give your board any light on the subject.

The most casual observer must be satisfied, however, that our system cannot be compared to the system adopted in France and England.

The only light-vessels I have known anything of, on our coasts, are the light-vessel in the Vineyard sound, or rather off the inner part of Tucker-nuck channel; the one at the Sow and Pigs, off Cuttyhunk, and the miserable boat off Minot's. The first is well enough for the purpose; the two last I have no confidence in, as to their safety, and consequently I think no light at all better than one liable to be carried away at any time. The Minot light has been improved, as I understand, by the introduction of reflectors of water, by J. W. Bennett. I visited and examined the site of the iron light-house at Minot's ledge last August, and made up my mind that it ought never to have been placed on the outer rock, but on the large dry rock a little inside of it; a large fog-bell on the outer rock could have been managed from this light with advantage. The system, or want of system, of buoys near our harbors, is a subject of remark and regret to all observers. Buoys for harbors should be much more conspicuous than they now are; and where the climate will permit, they should be large and of boiler-plate, with definitely fixed colors for the port side, and the same for the starbord side of the channels, &c. Most of our harbor-buoys are mere broomsticks, and cannot be seen on a clear night far enough to be of much use. All harbors, and particularly those where fogs prevail, should have a line of buoys running seaward eight or ten miles from the entrance of the harbor, as a guide in foggy weather; and they should be marked by numbers, so that the seaman may know how far off he may be. There should be a beacon or light-ship near Nantucket South shoal, if it cost a million of dollars! Trusting that these hints may not be entirely lost on the government,

I am, very truly and respectfully, your obedient servant,

R. B. FORBES.

Lieut THORNTON A. JENKINS, U. S. N.,

Secretary to the Light-house Board, Washington, D. C.

B—No. 19.

*Letter from Captain M. D. Ricker, commanding ship "John Haven," of
Portsmouth, N. H.*

OCTOBER, 1851.

SIR : In answer to yours of May 29th, I have to say, as to the number of passages, &c.:

For several years past I have been running regularly between New York and Liverpool, making on an average seven passages between the two ports.

On the passages out, and in clear weather, I have always run with confidence for the lights on Cape Clear, Kinsale or Tuskar, all three of which are excellent lights.

That of Cape Clear is situated on the island of Cape Clear, at the entrance of the Irish channel ; is a revolving light, at an elevation of 450 feet above the sea, and can be seen eight leagues in clear weather ; but owing to its great elevation and the hazy atmosphere generally hanging about this coast, it is not at all times to be relied upon at this distance. To obviate this, there is now building on Fastnet rock, to the southwest of the cape, a light-house, of which the light will be at an elevation of 130 feet above the level of low water, and will most likely be seen when that of Cape Clear will be obscured by fog or haze.

The next light is that of Kinsale, on the Old Head of Kinsale, 35 miles to the eastward of Cape Clear. This is a fixed light of great brilliancy, at an elevation of 300 feet above the level of low water, and is seen in clear weather seven leagues ; between Kinsale and Tuskar there are other lights, all of more or less importance to the mariner ; and on standing for the land at night, one or the other of these lights is sure to be seen in clear weather, such is their proximity to each other.

The next in importance is Tuskar light, on Tuskar rock, at the southeast point of Ireland, and six miles from the coast ; the light is at an elevation of 125 feet above the level of high water ; shows a revolving light of three faces, one every two minutes, of natural color, and every six minutes one of deep-red color, distinguishing it from all other lights on the coast ; it can be seen five leagues. In foggy weather, a bell is constantly tolled. All these lights are well kept ; lighted from sunset to sunrise without interruption, and, as a general thing, are steered for by ships bound into the St. George's channel, without fear, confident of their being seen in good time.

On the return passage to the westward, and with a fair wind, I run for the Highlands. These lights, I think, are as good as any on the coast ; in fact good enough. They are considerably elevated, and can be seen 20 miles in clear weather. I should think that little or no improvement could be made in these lights, so far as regards range, &c.

I should think that Fire island light might be very much improved in brilliancy. I do not think that it can be seen over nine miles, and be depended upon, while it ought to be seen 15 miles at least. Sandy Hook light is a good one, and can be seen 10 miles, which is far enough to answer all purposes.

The best lights which I have seen on the coast of the United States are Cape Ann, or Thatcher's island, Boston, Cape Cod, and the Highlands, all of which are good lights, and will compare favorably with most of those on

the coasts of Europe as regards range and brilliancy. The Tortugas light is also a good one, (having seen it lately) and can be seen over 12 miles easily, and is a wonderful improvement upon the one lately exhibited in that locality.

If it were possible to build a light-house on Carysfort reef, I know of no place where a light would be more beneficial. There should be another on Indian Key, and one in the neighborhood of Loo Key; in fact, the lights on this reef should be so close together, that no ship should stand in for the Florida shore without seeing a light. I am aware that this would be a death-blow to the wrecking fraternity, but never mind that; ship-owners, and the interests of the commercial community generally, would be benefited, and the wreckers can find other business.

If the British government could be prevailed upon to place a light-boat on the Gingerbread Ground, and a light-house on the Great Isaac, also one on Orange Keys, and with the additional aids of those light-houses I have mentioned on the Florida coast, then this gulf, instead of being an absolute terror to the generality of ship-masters, could be navigated with facility; and I have no doubt that I speak the mind of every ship-master frequenting this gulf, when I say that there is no navigation anywhere attended with so much anxiety, and that has had so little done to improve it in the way of lights, &c.

With regard to the light-vessels on the coast of the United States, I am not familiar with any of them with the exception of the one off Sandy Hook. I have never considered that vessel as of the least utility whatever, and have always thought that she might be more advantageously employed elsewhere. The Highlands, Sandy Hook, and the beacon-lights, are generally in plain sight before the lights on the light-vessel are seen.

I have thought that a bell-buoy moored about due east of the bar, two or three miles off, would be of much more service than a light-ship. At Liverpool, one is placed in a position that a course can be shaped from it for either channel. The pilots, guided by the lead, run for this buoy, unless in very stormy weather; the steamers always run for it, and with a tolerable certainty of seeing or hearing it. The buoy itself can be seen some distance, being about the size of a ship's long-boat, and sharp at both ends. The bell is raised about six feet from the deck of the buoy, and strongly guarded with iron braces, &c.

The other buoys in the channel are large; black on one side of the channel, red on the other, all numbered: and those in particular places, such as on spits, &c., have something besides to designate them—either a representation of a flag in metal, or something of the sort—so that a pilot running in, in thick weather, (which they often do,) is never at a loss to know what buoy it is the moment he sees it.

With regard to the general system of buoys, beacons, &c., of the United States, I am not familiar enough with the subject to give an opinion; no doubt those in the harbor of New York might to advantage be improved, as I have heard the pilots frequently complain of them; but how it is to be done, I cannot say.

Very respectfully, yours, &c.,

M. D. RICKER.

Lieut. THORNTON A. JENKINS, U. S. N.,

Secretary to Light-house Board, Washington, D. C.

B—No. 20.

Letter from Captain Thomas J. Heler, commander of the ship "Shirley," of Boston.

NEW ORLEANS, November 10, 1851.

DEAR SIR: In reply to your communication of May 29th, I would say, that I make one passage per year from a northern port to New Orleans, and two voyages from thence to Europe. On my way to New Orleans I run for the "Hole in the Wall" light, (revolving,) which can be seen from the deck of a ship of 900 tons, in clear weather, sixteen miles. I generally pass around the "Isaacs," up the Gulf, and pass Gunkey light, (which is also a light of the first order, and can be seen from twelve to fourteen miles,) and around the Tortugas to the river Mississippi. I have only seen the Tortugas light once, and that was a long time since. The lights on the South point and at the SW. pass of the Mississippi are of a fair class, and in good weather can be seen twelve miles. In going to Liverpool, if the wind is SW., I run for "Old Head of Kinsale;" if to the W., or north of that point, I run for Cape Clear; and, returning from Liverpool to Boston, if the wind is SW., I run for Cape Cod; if the wind is E. to NE., I run for Cape Ann. The late light on Minot's ledge was one of the best on the coast of the United States, being very brilliant and clear. Boston, Cape Cod, and Sandy Hook lights, I consider the best on our coast. Cape Cod light is, at times, obscured by haze, and then not readily seen. Charleston (S. C.) light is a poor one, and cannot be seen far at sea.

All the lights in St. George's channel are of the first order, well kept, punctually lighted, and are kept burning their full time. The best of them, I consider, are the Tuskar, South Bishop, Bardsey, South Stack, and Skerries. From my experience, I have come to the conclusion, generally speaking, that the lights on the coast of England are more brilliant, clearer, and can be seen at a greater distance, than those of the United States. Perhaps this arises, in part, from the atmosphere.

I have never seen any of the floating light-ships of the United States; therefore I cannot compare them with those of England.

The buoys of England are far superior to those of the United States; they being can-buoys, painted of different colors and numbered; those of the United States being spar-buoys, and in a strong tide-way and thick weather cannot be seen far.

I am not able to give any account of the apparatus employed in any lights, never having been inside of a light-house.

Very respectfully, yours, &c.,

THOS. J. HELER.

T. A. JENKINS, Esq., Washington, D. C.

B—No. 21.

NEW YORK, December 10, 1851.

SIR: Your circular of May 29, 1851, has been received; and, as far as I am able, I will answer your inquiries.

For the last two years I have commanded the ship James Wright, in the

packet service, between this port and Liverpool, making three voyages per annum.

On the outward passage I generally have followed the great circle route, and have usually made either Cape Clear or the Old Head of Kinsale, on the south coast of Ireland. The light on Cape Clear is a bright revolving light, intended to show about twenty-five miles; but, from its great elevation, (455 feet,) and its peculiar construction, it is not to be depended on, as it is frequently obscured by haze and clouds. It revolves once in two minutes, and is visible only ten seconds. Old Head is a brilliant fixed light of the first class, and I have seen it, in clear weather, about twenty-five miles. To the next light that we make, viz: Bally Cotton island, I would invite your particular attention, as a distinguishing light. It is a very bright, shooting light, showing every fifteen seconds, and is so remarkable that it seems impossible to mistake it. The lights on the coast of England and Ireland, I think, for brilliancy and range, are unsurpassed by those of any other nation; and they are well attended throughout the night. They have only one kind of lights that I cannot approve of, viz: the *mixed*, such as Mine Head, near Waterford, and Bardsey, on the coast of Wales, they being composed of two ranges of lamps in one lantern, one fixed and one revolving, the light being continually visible.

Their light-vessels are good; and, as they have duplicates, we run for them with confidence; and I have never known one to be missing even one tide after the abatement of the gale that broke the first adrift.

The lights of France are generally too high for use, as they are invisible in thick weather, and in clear weather too much resemble stars when seen at a distance. Of their light-vessels I can say nothing, as I have seen none of them.

Our light-house system, I am sorry to say, is the poorest of all commercial nations I have visited. Our lanterns are poor, and not always well attended; and, as a general thing, our navigators put but little confidence in them. I have been many years in the coasting trade, and have passed the Gulf of Florida more than one hundred times, and in all that time I have seen the Cape Florida light only twice, while the light on Gunkey is always visible. The revolving light on the east end of Abaco I have frequently seen twenty-five miles, and since that has been lighted I have never laid to for daylight to enable me to pass the "Hole in the Wall."

Lights on the Stirrup key and Great Isaac are much wanted for our outward bound vessels from the northern ports to all ports of the Gulf of Mexico. I know of only two good lights on our whole coast, viz: Boston harbor and the Highlands of Navesink, N. J. Approaching New York from the eastward, we have *no* lights that we can run for with confidence until the Highlands. Montauk Point and Fire island are *poor*—seldom seen more than ten or twelve miles. From the south, it is as bad—*Barnegat being worthless*. As to our light-vessels, I consider them *worthless* for our foreign trade, from the fact that, having *no* duplicates, they are often either adrift or taken into port for repairs, which happens so often that no navigator who has been absent three months can have any confidence in many of them. In May, 1845, I ran the ship Rienzi, of New York, ashore on Carysfort reef, on a very bright night, with a good lookout aloft and no light visible; but when daylight came the Carysfort reef light-vessel was plainly in sight from our decks. Before I left the wreck, the ship Newark ran ashore within a mile of us from the same cause. Query: Why cannot we have as good

lights on our side of the channel as the English have on the Bahama side? The Tortugas light is so low, that it is frequently obscured by the spray from the reef. Light-vessels should, in my opinion, never have less than two lights, as most of our large ships carry a lantern on the front of their bowsprit caps, which might lead to mistakes. A light-ship at Nantucket shoals would be invaluable to our European trade bound to New York, as well as our southern and West Indies trade bound to New Orleans, and I think that a suitable vessel might be kept there as well as the Saltees light-vessel on the south coast of Ireland, or the Leman and Ower in the North sea, and many others that might be named. Liverpool, England, requires three light-vessels, and to keep them at all times in their places has five vessels, viz: three on duty and two in port, but always ready to go out at one hour's notice.

I think that one cause of the poorness of our lights may be found in the quality or kind of glass used in the lanterns, and another in the diminutive size of the lanterns themselves.

Our system of buoys has been improved within the last year, but still is much behind England and France; and I believe that all the European nations have adopted this system of red and black buoys, placing all the red buoys on the *starboard*, and all the black ones on the *larboard* side of the channel going in, and numbering them, commencing with the outer ones. In England the buoys at angles or turns in the channels have perches on them, and they are all of a much larger size than ours.

The English use no *spar* buoys in the ship or main channels to their harbors, and use green buoys over sunken wrecks. Although there have been many vessels sunk in and around New York harbor within the last twenty years, I do not remember to have ever seen a buoy of any kind moored over any of them by the government or collector of the port.

I cannot too much recommend the use of floating machines like the bell-buoy off the bar of Liverpool: such a machine moored off the bar of New York would be worth much more than the floating light now moored off the port. For sunken rocks and shoals near the coast, monuments erected on shore, and whitewashed or painted, and placed in range with the rock or shoal, would be invaluable for coasters.

I now come to the subject of general complaint among ship-masters of all nations trading to our ports; and that is, the manner and insufficiency of the notice given us of the erection, lighting, removing, repairing and description of our light-houses and light-vessels.

With us the practice appears to be for the collector of the district to *advertise* the fact in some newspaper for two or three weeks, and let it rest, supposing that all will take notice accordingly; whereas I do not think that one in fifty even of our coasting vessels knows anything of it, and it is impossible for any foreign traders to know anything of it. In England we have at least six months' and generally a year's notice of any alteration intended; not by newspaper advertisement, but by handbills posted near where all masters must go to enter and clear their ships, and at all the offices of the foreign consuls.

You may think, from the length of this communication, that these complaints are but the growlings of an old sailor; but you asked for my opinions, and I have given them freely. I hope that you may find some one better qualified to give the information you seek, than myself. If I can be

of any further use to you hereafter, I shall be happy to give you any information I may possess.

Respectfully, yours,

SAMUEL CLARK.

[To Lieut. T. A. JENKINS,
Secretary to Light-house Board.

B—No. 22.

Letter from Captain W. R. Bradish, commanding the packet-ship "Yorktown."

NEW YORK, September 28, 1851.

SIR: Since my arrival I have received your note of May 29, in reference to the lights on the coast of the United States. I have sailed between this port and London three voyages a year, for the last eighteen years, and during that time have seen the lights only in the vicinity of this port—say from Montauk Point to Barnegat. The Highland lights are good; the revolving light is most brilliant, and can be seen in clear weather twenty-five miles. Fire Island and the Hook lights are good according to their elevation. The other lights I have seen so seldom, that I can hardly judge.

In running for the British channel we make the Lizard two lights, fixed, elevation 224 feet, very brilliant; can be seen twenty-two miles. If we do not see them we endeavor to make the Start, elevated 204 feet, revolving, seen nineteen miles; Beechy Head, revolving, elevated 285 feet, seen twenty-two miles; Dungenness, elevated 92 feet, seen fourteen miles; South Foreland, two, fixed, elevated 372 and 275 feet, seen twenty-five and twenty-two miles. These are the most brilliant lights I have ever seen. (The Highland revolving light on our coast is as good.)

The floating lights on the coast of Great Britain are certainly far superior to the one moored in the harbor of New York. Their lights seem to burn more brilliantly, and I have never known any light but to be kept lighted from sunset to sunrise.

The buoys on the coast of Great Britain are larger and more sightly than on the coast of the United States, and are kept in first-rate order.

If by chance there should be a wreck sunk, there is immediately a buoy, painted green, with the word "wreck" placed upon it, even where there is sufficient water over it for the largest ships. In fact, everything is done for the benefit of navigation that can be done on the coast of Great Britain.

I do not know that I can say more concerning this subject; and if my humble experience will be of any service to your most praiseworthy design, I shall feel most happy to have been of any use to you.

Wishing you success in your undertaking, I am, sir, your humble servant,
W. R. BRADISH.

Lieut. THORNTON A. JENKINS, U. S. N.,
Secretary to Light-house Board.

B—No. 23.

Letter from Captain J. C. Delano, commanding ship "Albert Gallatin."

NEW BEDFORD, November 25, 1851.

SIR: I found, on my return from Europe a few days since, your queries touching the comparative usefulness of the foreign and United States light-houses, to which I hasten to make a brief reply.

I do hope you will be able to show to a committee of Congress such a * * * * * state of things, that that body will no longer withhold the means of improvement.

Of late years I have made six passages per annum between New York and Liverpool; previously I was in the London packets, and some years in the East India trade. The last five years I have not been at sea, except as passenger several times to and from Europe.

The lights I generally ran for were Scilly, Cape Clear, Kinsale, Waterford, Saltees, Smalls, Holyhead, &c. On the American coast, Highlands of Navesink, Fire Island, Barnegat, Long Island, and occasionally we see Block Island, Gay Head, Sankaty Head, &c., &c.

Question as to location and character of *foreign* lights, comparative brilliancy and range, apparatus, steadiness, certainty, to those of the United States, in positions of equal importance?

Location of sites generally judiciously chosen by experienced and competent men, not by custom-house officers or politicians; character of houses substantial, and of the most durable materials, and much more commodious than ours. Apparatus of most of the English lights, of the best reflecting, although many of the principal lights are on the dioptric or Fresnel plan. I observed the remarkable brilliancy of the lights along the coast of Holland, and on the coasts of Sweden and Norway, and in the Baltic seas, and was told that they were on the Fresnel or dioptric plan, and all agree that they are more economical than the reflecting lights. When reflecting lights are used they are infinitely superior to ours, being 18 to 22-inch reflectors, and, I am assured, costing £30 to £35. In brilliancy, range, and steadiness, the European lights are certainly far ahead of ours. As to usefulness, of course increased brilliancy and range give that characteristic. Most of the European lights can be seen as far as the curvature of the earth will allow objects to be seen. The best coast lights of the United States are, I think, Boston, Sankaty Head, and the Highlands of Navesink. In characteristic distinctions we are very deficient; accidents of a very fatal nature often occur from a want of the means of distinguishing lights. Our light-ship system much needs reform; they are announced as being in position, but before the navigator *gets there* they are gone. Duplicates should most certainly (as in other civilized parts) be in readiness to be towed to the station as soon as vacated; better have none than no relief. There is an unfortunate craft off Cutterhunk, which has been the cause, by the periodical desertion of her post, of two or three shipwrecks on the "Sow and Pigs." It would be a benefit to commerce and a saving to the treasury, I think, to take her away and reserve her as a spare light-vessel, after building a light-house on the extreme southwest end of Cutterhunk, with a good dioptric light of the first order. I don't believe that it is practicable to erect one on the rocks; there is in fact no need of it, as the rocks lie only three-fourths of a mile from the point.

Our system of buoyage is in great need of better management. Ignorant men, pilots, captains of coasters, anybody in fact, are employed by contract to place the buoys, and they are seldom placed alike for two successive years. An officer of the navy, or some competent person, should be appointed in each district, who could with a sextant place the buoys by angles or by three known points.

It often happens that a black buoy will be found by the navigator where the chart calls for a white one, as the person who superintends this operation disdains a reference to the coast survey, most likely because he could not understand it. The buoys in the important port of New York are very much out.

Navigators and ship-owners do now trust, since the appointment of a light-house board composed of men of science and nautical experience, that there will be a change, and that our light-houses, buoyage, and beaconage, will be improved so as to approach the standard of European excellence. Our light-keepers are generally very inferior and incompetent men; * * * seldom have had any instruction in their duties. In the English and other European lights they are required to keep a meteorological register. What a mass of interesting facts might be collected along our extended coasts, if this plan were adopted. I have heard great objection urged to the use of the dioptric light of Fresnel—or I should say to the central lamp, with the concentric wicks—that it is complicated, liable to get out of order; and being but one lamp, may go out in the night. I was assured that a second was always kept at hand, but not a single instance in the twenty-five years' experience had occurred of a failure. The oil used is not so good as our sperm oil; they are now trying in England the refined rape-seed oil as a substitute for sperm, and I have it from good authority that it is equal to sperm. I do not think it would do in our climate in the winter. I sent home a canister of the article, which I had from Mr. Briggs, the London contractor, and I find it much inferior in its burning qualities to sperm oil—very little better than whale. One more word as to location. It is quite ridiculous what a mess the officers of the customs make in placing lights, or misplacing them. Witness Wing's Neck, Palmer's Island, Cutterhunk, where the light-house might have been so placed on the southwest point, instead of northwest, that it would have rendered unnecessary entirely the "Sow and Pigs" floating light-vessel. If Palmer's Island light-house had been ten feet higher, it would have been a most capital range with Clark's Point light to avoid all the ledges in Buzzard's bay. In fact, by getting them in range, a vessel may sail in or out in the darkest night between the ledges of that dangerous bay.

Very truly, yours,

J. C. DELANO.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to Light-house Board, Washington, D. C.

B—No. 24.

Letter from Captain E. E. Morgan.

NEW YORK, November 20, 1851.

SIR: I have made one hundred and fifty-four passages from this port to London. Of course, I am well acquainted (or ought to be) with all

the lights from the Nore to Scilly, and Cape Clear, also the French coast from Brest to Ostend.

I don't think the most is made of our light-houses. They are not kept clean and in good order. They should have printed regulations furnished by the light-house board. They should keep a log of the weather, barometer, thermometer, sails that pass, wrecks, and all the particulars, &c., and send them monthly to the board.

Bells on light-stations where turning points or going into rivers, &c., would be very useful and without much expense. We want one very much at Saybrook light. The writer has frequently been detained there by the fogs. There are many steamers that go in and out there. A floating light in Nantucket and George's shoals is very necessary.

The light at Calais (France) is the best that I ever saw. The Highland light at New York is good.

The best kind of work altogether, lantern and all, is Skerryvore, in the north channel for Liverpool.

All harbors should be so buoyed that a stranger could take his vessel in by daylight; say red on starboard, and black on larboard hand. The kind of buoys should conform to *ice or no ice*.

If I have not answered your note as you wish, or fully enough, I shall be most happy to write you others.

Yours. &c.,

E. E. MORGAN.

TO SECRETARY OF THE LIGHT-HOUSE BOARD,

Washington, D. C.

B—No. 25.

Letter from Lieutenant Henry Rodgers, United States navy, commanding United States mail steamer "Falcon."

U. S. MAIL STEAMSHIP FALCON,

New York, November 30, 1851.

SIR: In answer to the questions proposed in the circular of the light-house board, I give herein such meagre answers as my experience affords.

I have averaged twelve voyages or twenty-four passages per annum between New York and Chagres, *via* Charleston, Savannah and Havana: the voyages sometimes divert to New Orleans; in these voyages running to make, and sometimes making Barnegat, Old Inlet, Roanoke, Hatteras, Cape Lookout, Cape Fear, Cape Romain, Charleston, Savannah, Cape Canaveral, and Cape Florida lights, and those at the mouth of the Mississippi on our own coast, (trusting more, however, to the lead and astronomical observations, than to the lights,) Double-Headed Shot Key and Gunkey, English lights on the Bahamas, and those at Havana and Cape San Antonio, on the island of Cuba.

The locations of foreign lights are as above named, and on low points of land. In elevation I think they are not superior to the generality of ours

but in brilliancy and good keeping surpass our best and most important ones, except perhaps those on the Highlands of Navesink.

I do not know how our lights compare with those on the European coasts; but, judging from the English and Spanish colonial lights, would suppose ours to be greatly inferior. Decidedly the best that I have seen on our coast are those at the entrance of New York harbor, on the Highlands, resembling in appearance those at Havana, and Cape San Antonio, which I have understood to be French. From New York to Brazos Santiago our lights might undoubtedly be improved, and a better system of keeping established.

Wherever a light is placed, it should be a good and reliable one, or might, perhaps, as well be dispensed with entirely, as vessels depending upon it are as likely to get into difficulty through such reliance, as to be guided by it.

The coast of Florida and its reefs, particularly demand a good system, so that vessels in coasting from Cape Canaveral to Tortugas might never be out of sight of some light; and they should be so distinguished by fixed, revolving, double and colored lights, that the navigator might readily fix his position by sight of any one of them.

I have rarely passed the Florida reefs without seeing a recent wreck or wrecks.

The English lights on the Bahamas, and the Spanish on the island of Cuba, may be seen in good weather at a distance of twenty miles, with a good deal of certainty; and I have seen them at a considerably greater distance from aloft. Those on our coast are generally, when seen, so dim and uncertain, that it is difficult to form any correct idea of their distance.

The flashing lights at Havana and Cape San Antonio seem to me to be the best in this respect; no sooner does the light appear above the horizon than it flashes out boldly and distinctly.

False lights have been and are not unfrequently complained of on our coast, which is pretty good evidence of the inferiority of the legitimate ones.

During a large portion of the year, our seacoast is subject to foggy and hazy weather; and at such times, signals by means of rockets, guns, whistles, or bells, might be used with benefit to commerce.

Would not the revenue lost by vessels wrecked, or obliged from injury to throw cargoes overboard, go far to cover the expense of the desirable improvements?

Additions are almost daily being made to our steam-marine, and each steamer from New York to New Orleans, or any Gulf port, is for the great part of the way a coasting vessel, whatever her size.

These vessels carry immense numbers of passengers and the most valuable cargoes; and to them, competing as they must and will do for speed, and shortening distances as much as possible, good lights are almost indispensable.

It is customary for vessels navigating through the Gulf to the northward to run for the English lights on the Bahamas—for no other reason, that I can see, (as certainly the distance is increased and the current not so favorable,) but because there is no confidence felt in the lights on the Florida coast.

From an examination of a chart of our coast, on a small scale, where each light is represented by a patch of red paint, and the intervals between them insignificant, it would, no doubt, appear to be brilliantly illuminated, but

experience leads to a different and not pleasant conclusion. I have often, at Havana, heard captains of vessels earnestly discussing the difficulties of Gulf navigation, each one astonished that, steering some particular course, he fetched up at some point beyond all calculation out of his reckoning; owing in some cases, no doubt, to the uncertain currents, and in others to deviation of compasses.

But from whatever cause, such errors, and liabilities to error, are attended with great risk and anxiety. Good lights and enough of them would make plain sailing of what is now merely groping in the dark.

In running for the position of a light on our coast at night, if I make it I am thankful that the reflectors have been particularly well burnished; and if not seen, I conclude that the oil is bad or the lamps not properly supplied, or that the light-house is washed away or blown down, so insecurely are they sometimes built.

I regret that I have been compelled to run so hurriedly over a subject of so much interest and importance, but cheerfully add this mite of experience to the mass of information which the board has doubtless collected already, believing that any changes for the better in the lights on our coast will be of immense benefit to commerce and to the country.

Very respectfully,

HENRY RODGERS, U. S. N.,
Commanding Steamer "Falcon."

Lieut. T. A. JENKINS,

Secretary to Light-house Board, Washington, D. C.

B—No. 26.

Letter from Captain Theodore Julius, commanding the packet-ship "Tonawanda."

OCTOBER 8, 1851.

SIR: I was too busy to reply to your communication while in Philadelphia, and hasten to do so now, and hope to be in time. I shall proceed at once to answer your questions.

I generally make six passages per annum between Philadelphia and Liverpool.

I run for the lights on the south coast of Ireland, those of St. George's channel and Capes of Delaware.

The above-mentioned foreign lights are of the first order. I cannot give any description of apparatus employed therein. The average distance to which they can be seen is at least twenty miles; they are certain of being lighted from sunset to sunrise, and I can scarcely make any comparison between them and the lights at the Capes of Delaware; and I consider the latter of much greater importance than the former, owing to the shoals which lay off at a considerable distance from the land, which is low, while the coasts of Great Britain and Ireland are generally high and bold. Our lights will not bear any comparison with the lights of Great Britain and Ireland.

I consider Cape May light the best near the Delaware; and as I have not been anywhere else for years, I can say nothing about others, and there is

not one of the foreign lights above mentioned but what is far superior as to range and brilliancy.

There is a greater variety of distinctions in the lights of Europe than on our coast.

The light-vessels on the coasts of Great Britain show much better lights and are much more certain to be in their position than ours, as I never found them (those of Great Britain) away from their position, and I have ours several times, viz: in June, 1842; and this year, twice the light-ship on the Five-fathom bank was not in her position.

Our system of buoys, beacons, and sea-marks, I am sorry to say, will not compare with that of Great Britain. There is not a buoy in the bay or river Delaware worthy the name, as they are thin spar-buoys, and hard to see even in day-time, while those of Great Britain are generally large can or nun-buoys, and can be seen at night unless it is *very* dark.

I would suggest that a light-vessel be placed on the northern part of Fenwick's Island shoal, and a bell beacon on the southeastern extremity of the "Overfalls."

I remain, very respectfully, &c., &c., &c.,

THEODORE JULIUS.

Lieut. T. A. JENKINS, U. S. N.,
Washington, D. C.

B—No. 27.

Letter from Captain James C. Luce, commanding United States mail steamship "Arctic."

NEW YORK, November 15, 1851.

SIR: Your favor of 29th May last, making inquiries relative to lights, buoys, &c., was received by me just on the eve of sailing, and would have been answered on my return from England, but by some means it was mislaid; I have only just found it, and hasten to reply.

Since being in command of a steamer my number of passages between New York and Liverpool is from twelve to fourteen per annum. Going eastward we usually run to make Cape Clear, Old Head of Kinsale, Cork, Waterford, Tuskar, Arklow, (floating,) and Wicklow, on the south and east coast of Ireland, and Smalls, Bardsey, Holyhead, Skerries, and Point Lynas, on the coast of Wales. The same coming westward, with sometimes the addition of Cape Pine on Newfoundland, and Sambro off Halifax. Usually, we run to make Montauk and Fire Island lights, on Long Island, both of which are miserable lights, and frequently cannot be seen in fine weather, till close aboard of them.

The lights on the Highlands of Navesink are about the only ones on our coast, with which I am acquainted, that will compare favorably with those on the coasts of England and France generally. It is my opinion that we should have both Fire Island and Montauk replaced with as good lights as can be constructed, with the addition of, at *least*, one more about the centre of the coast of Long Island—to exhibit say two lights, a red and a white light, one above the other, or some such distinguishing mark, that it may be readily known from other lights about the coast of New York.

I think also that it is of the greatest importance that a light should be built or stationed at Nantucket shoals, provided with a very large bell, to be kept ringing in thick weather, "to which we are liable three times in four in passing there." Buoys moored along the coast of Long Island and Jersey, say fifty miles each side of New York harbor, of different colors on each side, and numbered, would often be of great service and prevent shipwreck. The same precaution, of course, may be used on many other parts of our coast with equal utility. In England there are always kept ready spare or duplicate buoys and light-ships, in case of the removal of any by accident or otherwise. The lamps in general use in Great Britain are De Ville & Co.'s, 367 Strand, London—Argand lamps, 22-inch reflectors, which are of copper, lined with silver; the lamp is to be in a focal position.

All the lights off and at the port of Liverpool are supplied with the best Olive oil, which goes through a process of refining by filtration, prepared by Bancroft at Liverpool. It is said to produce a much more powerful and brilliant light than any other oil, and a very great saving of expense is gained.

In buoying channels the following system is adopted in England: red can-buoys on the starboard hand entering the channel, and black nun-buoys on the port side; checkered buoys on any knoll in the centre; bell-buoys are usually placed at the entrance of a channel; iron buoys are almost universally in use, with compartments. Nun-buoys, 9 feet by 4 feet in the centre; can-buoys, 7 feet by 4 ditto; the latter tapering to $3\frac{1}{2}$ feet at top, having water-tight bulk-heads in the centre.

At the entrance of some channels, buoys are 16 feet by 6 to 7 feet. The accompanying book of light-houses, &c., may aid you in giving you such information as you require.

I am, sir, very respectfully, your obedient servant,

JAMES C. LUCE,

Commanding U. S. mail steamship "Arctic."

THORNTON A. JENKINS, Esq., *Washington, D. C.*

B—No. 28.

Extracts from a letter received from Captain Robert Leslie, of Baltimore.

The undersigned, not having crossed the Atlantic but once during the last thirteen years, is unable to respond to the queries propounded; he may say, however, that during his active command as a master-mariner, the superiority of the English lights attracted his attention and inquiry.

In the Bay of Fundy, the lights are better, and have a greater range and brilliancy, than on the southern coast.

ROBERT LESLIE.

BALTIMORE, December 3, 1851.

B—No. 29.

Letter from Captain E. Crabtree.

NEW YORK, December 22, 1851.

SIR: My time is so entirely occupied by the business in which I am engaged, that I shall be obliged to reply briefly, and in rather general terms, to yours of the 29th May last, requiring my opinion as to lights, beacons, &c.

The voyages I have been employed in making for the last four years are hence via Cowes to Bremen, and back to this port; consequently I have no opportunity of judging of any of the lights upon our coast, except those which mark the entrance to this port and the one on Fire island. These are all good and appear to be well kept. There is a brilliancy about the most important lights on the English coast, that I think superior to even the Hook and Navesink lights here. How this is attained I am unable to say, but it is probably owing to the superior quality of their glass and reflectors. The light on Tuskar rock, St. George's channel, is a remarkably good one, and in clear weather may be seen as soon as it is brought above the horizon. Also the light on the Start point (British channel,) which is equally good. One of the most dangerous points on our coast north of Hatteras, is the South shoal of Nantucket. The ship *Ivanhoe* was lost there last year, with all on board, and many others at different periods.

The distance of the nearest point of the island of Nantucket from the shoal is too great to depend upon seeing a light placed there, even if it were as good as the Tuskar. It is important that some means should be adopted to mark this spot, either by a good floating light, moored say half a mile north of the shoal, so that it might afford some shelter to the light-ship in heavy southerly gales. The situation is not more exposed than that of many in England. The light-ship near the "Seven Stones," northeast of Scilly, is exposed to the whole rake of the Atlantic in the northwest gales, which blow with great fury during the winter months. This light-ship, the one on the Saltees, and the two that mark the north and south sand-heads of Goodwin shoal, also those on the Galloper and Knock shoals in the North sea, are quite as much exposed as if anchored off the southeast point of Nantucket shoal. Yet you never hear of their drifting from their berths. The situations of these lights (except the Galloper and Knock) are rendered much more perilous by the rapid tides of the channel, which often during the spring, sweep them around broadside to the sea in the heaviest gales. It was this which caused the loss of the light-ship at the mouth of the Elbe last winter, with all on board of her. The ship swung round with the tide during a violent northwest gale, and the sea capsized her. A floating light moored near the South shoal of Nantucket would have but little tide to encounter—not enough to swing her against a brisk top-gallant breeze, and if properly moored with heavy anchors, might ride safely at all seasons.

The next best thing to a floating light, would be to place one or more mammoth buoys near the shoal. These buoys are twenty feet in diameter, made of boiler-iron; the lower end being loaded with four or five tons kentledge and a bell on top, twelve or fourteen feet high. The motion of the buoy would cause the bell to strike, and in the night or in thick weather would give notice of the danger. I have seen the mammoth buoy which

marks the Royal Sovereign shoal, English channel, at the distance of eight miles from our ship's deck.

Should these hints require any further explanation please let me know, and I will cheerfully give it.

Yours, respectfully,

E. CRABTREE,

Late Captain U. S. mail-steamer Hermann.

T. A. JENKINS, Esq.,

Secretary to Light-house Board.

B---No. 30.

Letter from Captain F. H. Hebard.

BROOKLYN, December, 1851.

SIR: I have duly received your communication as secretary of the light-house board at Washington, requesting such information as I can give, respecting light-houses, beacons, &c., in our own and such countries as I may have visited. In answer to these questions, I have to say that I am an old sailor, but can only give you a little information, and that of a general character, which you require. I have been for the last twenty-two years commander of a London packet-ship, and have made on an average six passages per year, or nearly so; having during part of the time remained at home to superintend the building of two new ships. Although previous to 1829 (the year of my first voyage to London) I was for five years in one Liverpool packet as mate and master, I can give you but little information in regard to the lights in St. George's channel, but the Tuskar and Holyhead lights are among some of the best in the world. I made a voyage to Liverpool in April last, and found there excellent lights, but not better than our revolving light on the Jersey shore, (Highlands of Navesink) which is the best on our coast. As regards the location, &c., of the foreign lights, I might write a volume. You will find them all described in the late publications of sailing-directions of Captain Martin White, R. N., and others.

I have no hesitation in saying that the lights, beacons, buoys, &c., of Great Britain, are far superior to those of our country.

In going to London, or bound through the channel to a port in the North sea or north of Europe, there is one light on Cape Grisnez, on the coast of France, opposite Dover, which surpasses any light in the world that I have ever seen. I have stood on Dover pier, and have seen it so plainly, that I thought it a large light six or eight miles off; all the Cinque Port and Trinity pilots acknowledge it to be the finest light in the world. How these lights are lighted I know not, or by what machinery, lens, glasses, &c., they are fitted, (first order Fresnel lens, eclipse light.) The lights on our own coast cannot compare with those of Great Britain and France, and our buoys and beacons are far behind them. As regards the harbor of New York, I could say much. In the first place, Fire island light is bad and uncertain, visible from six to fourteen miles, as it happens, in clear weather. We want a light-house or light-ship on Flynn's knoll; and it is the opinion of most of the old pilots and captains, that the light-ship should be placed on the south buoy of the bar. All the buoys should be enlarged, those on the bar par-

ticularly ; and they should be nun and can-buoys, with shapes and balls which could be seen above the break of the sea ; made of light hoop-iron.

It might be objected, that the ice would carry away the spindle in the winter ; but they could be unshipped or replaced if such were the case. A light between Fort Hamilton and Coney island, or Long island, would be of great service to vessels in coming up or going down the channel, being a guide after rounding the Spit, in coming into port. I know that a proper commission of experienced pilots, ship-masters, &c., with a good practical surveyor, could render the bay and harbor of New York easy of access, by placing such lights, beacons, buoys, &c., as a careful survey might dictate, at any time of day or night. The British government, through the careful surveys of the Trinity House, have ordered, since my first visit to the Thames, three light-vessels, and several beacons and buoys. They have in some places driven large piles to form a beacon, and in the Swin entrance of the Thames, have erected a light-house on piles driven into the sand, and at high water, in storms, the sea rages with great violence, but it has ever stood firm. The increasing trade and commerce of New York demand that no expense should be spared to render it so that it can be approached at all times of night or day, in moderate clear, or even in thick weather, and I hope to see it so in a very short time.

In addition to what I have before written, I would recommend that a light-vessel be placed on Nantucket South shoal. It will save many lives and a vast amount of property. It is not twelve months since the "Ivanhoe," a large and valuable ship, together with her entire cargo, and, what was of more value, the lives of every person on board, were sacrificed for want of this warning-beacon. Two other ships came near being lost at the same time, but seeing her on the shoal, tacked off in time ; night, thick weather, and a heavy gale coming on, they could render her no assistance. Bell-buoys might be useful in many places, at the entrances of our various harbors. Let them be not too large, strongly built, and firmly moored. I would also recommend that our light-vessels be not over-large, and built with a view of riding well at anchor and at moorings. I would also have several spare light-vessels always ready to replace those which may have broken from their moorings, or are removed for repairs, &c. It is time that the collector of a port give notice that on a certain day the light-vessel, &c., will be removed for repairs. Nine-tenths of the time, the inward-bound mariner has no knowledge of this, and is in entire ignorance of it, and fatal results are the consequence. I would also say, that since my first navigating the English channel, the British government has erected light-houses on Start Point in Devonshire, St. Katharines, Isle of Wight, and Beechy Head in Sussex ; all of them of great usefulness to seamen in navigating that channel, and are most willingly and readily paid for by the ship-owners. These lights have saved many vessels from shipwreck, many lives, and a vast amount of property from destruction. A similar course by our government will be attended by the best results ; and I would recommend that the rules and regulations of the Trinity House, in London, are of the most perfect organization, and consulting them would, I have no doubt, be useful to the board established at Washington.

Your obedient servant,

F. H. HEBARD.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to Light-house Board.

B—No. 31.

NEW YORK, August 6, 1851.

SIR: In addition to my communication of the 4th instant, my attention has been called to the further improvement and safety of navigation for vessels passing the Bahama Keys, and entering and leaving the Gulf of Mexico.

During the last session of Congress, a petition was presented to the House for a light-house on the Florida coast, near Jupiter inlet, nearly opposite Memory Rock, on the Bahama side. Also, a memorial to the British minister in Washington, representing the necessity of a light-house on Memory Rock, and one on the Isaacs, Great Bahama Bank; and all these are necessary for the safe lighting of these passes.

To give suitable protection to commerce, and to vessels often passing the "Hole in the Wall," when bound westward, a light-house should be built on the western Stirrup Key; a light-ship, or a large buoy or beacon, placed on the Middle Ground; and a light-house or large beacon on the Orange Keys.

The proposed light for Memory Rock would answer the purpose if placed on the west end of the Great Bahama island.

I am, very respectfully, &c., &c.,

JOHN C. HOYT.

T. A. JENKINS, Esq.,

Secretary of the Light-house Board, Washington.

Recapitulation.

1st. Light-house at Jupiter Inlet, Florida coast.

2d. do. on Memory Rock, Bahama side.

3d. do. on Isaacs.

4th. do. on Stirrup Key.

5th. do. on Orange Keys.

6th. Light-ship, buoy, or beacon, on the Middle Ground.

B—No. 32.

Letter from Capt. W. R. Hoodless, commanding ship "Jacob A. Westervelt."

NEW YORK, November 29, 1851.

SIR: Your communication of 29th May last (respecting light-houses, buoys, &c.) is before me, and I will at once reply to it.

Question 1st.—I make on an average seven passages per annum, between New York and Liverpool. On the outward passage, we make the lights on Cape Clear, Fastnet, Rock, Kinsale, and Tuskar; we next make Holyhead and Skerries; all of which are elevated from seventy-five to one hundred and fifty feet above the level of the sea; all varying in character, as floating lights, revolving lights, and red and white, and are all of greater brilliancy than any that I have seen on this coast, (except the revolving light on the Highlands of Navesink;) they are lighted from sunset to sunrise, without fail.

I find the entrance of the river Mersey, at Liverpool, to be lighted and buoyed in a manner superior to any other harbor that I have ever entered.

At the entrance, or one mile from the bar, is a bell-buoy anchored across the tide, and can be heard half a league; it is rounded at the bottom like a barrel, which causes it to roll incessantly. Light-ships are placed in the channel at convenient distances, and *black* buoys on the port side, and *red* buoys on the starboard side of the channel. The light-ships are provided with fog-bells, so that ships can enter in foggy weather, which, I am sorry to say, is not the case with New York.

I am of opinion that the harbor of New York, and other harbors in the United States, might be so lighted and buoyed as to be accessible in all weathers, and at all times of night, even without the aid of a pilot. By reference to the plan of the harbor of New York, you may perceive that a light-vessel might be stationed ESE. $1\frac{1}{2}$ mile from the centre of the outer bar; one at the end of the Spit, or at the entrance of the "Swash" channel; one at the west end of the Spit, or "Fairway channel;" and one in the mid-channel opposite the black buoy, at the west end of the "Swash" channel.

All the light-vessels should be provided with fog-bells, and the channels be plainly buoyed out with black, white, and red buoys. These buoys should be placed on the edge of the banks and shoals, and not be more than two miles distant from each other. The buoys on the opposite side of the channel should be the same distance apart, and placed on the most prominent parts of the banks, &c., &c.

I find that many of our harbors might be lighted and buoyed at a much less expense, and of more practical use to strangers as well as pilots. The present method of lighting and beaconing our harbors is useful only to pilots, or persons well acquainted with our ports.

If all the harbors in the United States were lighted and buoyed as they might be, any vessel could in stress of weather, by reference to the "Coast Pilot," enter many of our ports even without the aid of a pilot.

I am, sir, your obedient servant,

W. R. HOODLESS.

Lieut. T. A. JENKINS, U. S. N.

Secretary Light-house Board.

B—No. 33.

Letter from Captain R. W. Foster, commanding steamer "City of Richmond."

JANUARY 3, 1852.

SIR: In answer to your circular of the 29th May last, relative to the erection of light-houses, the placing of buoys, &c., I have the honor to state that the prevailing fogs on our northern coast during the spring and summer months are great impediments, even to the most skilful pilots, finding the entrance to New York harbor. Hardly a year passes without vessels getting stranded on the beach in the vicinity of Sandy Hook, from this cause. A bell-buoy moored on the bar would, under such circumstances, be a sounding guide to the proper channel, thereby preventing numerous disasters.

The Romer and Flynn's Knoll shoals, New York bay.—A stone beacon is erected upon the former, which, for any purpose except during day-light or moon-light, is of no use whatever. A floating light, exhibiting a red color, moored on the east end of Flynn's Knoll, would be a most desirable guide for the Ship and Swash channels; but as, during the winter months, the season of the year such a light would be the most required, it would, on account of the heavy drift-ice, be impossible to retain it at the station. For this reason a beacon-light erected on the Romer shoal would answer every purpose. A small breakwater, more to encounter the heavy pressure of the ice than the violence of the sea, would be necessary for its protection.

James river, Virginia.—For the safety and facility of vessels navigating this river in the night-time, it is indispensably necessary, if approved by the board, that there should be placed upon the following sites, viz:

A stone beacon on the White shoal.

A small light-house on Davis's point.

A small light-house on the Point of Shoals.

A floating-light on Lyon's Creek shoal.

A small light-house on Jordan's point.

The channels bordering these shoals are narrow and intricate; and as the river at these points is very wide, there is, in the night-time, no guide by which vessels can pass with safety; moreover, the soundings are of such a nature as cannot be depended upon.

Now that steam communication by sea from our principal mercantile ports to Petersburg and Richmond is greatly on the increase, the aforesaid structures would prove highly beneficial to sailing-vessels as well as to steamers.

I would respectfully refer the board to Mr. James Skinner, of Norfolk who is a branch pilot and superintendent of buoys for James river.

I am, very respectfully, your obedient servant,

R. W. FOSTER.

Lieut. T. A. JENKINS, U. S. N.,

Secretary of the Light-house Board.

B—No. 34.

NEW YORK, December 12, 1851.

GENTLEMEN: It is represented to me by the agent of the underwriters, Captain V. Tiller, Mr. Joseph Gaskell, wreck-master of Somers Point, Absecum district, New Jersey, and Mr. Ryan Adams, keeper of the life-boat-house on Absecum beach, that the light-house on Tucker's beach, Little Egg Harbor, should be changed to Absecum beach, west of the inlet, on the land of the Messrs. Chamberlain, who will give it for that purpose. Believing them all to be fair and honest in these representations, I have asked for their reasons, and they state that the light on Tucker's beach is chiefly needed for vessels coming to the north; that the woods on Absecum beach hide the light, and vessels in consequence run on the shoals off Absecum, and sometimes on Brigantine shoals, both of which would be

prevented if the light-house were placed on Absecum beach ; vessels going south do not require it.

I submit the matter for your consideration.

Very respectfully, your obedient servant,

WALTER R. JONES,

President of the Board of Underwriters.

To the LIGHT-HOUSE BOARD, Washington.

Memorandum.—See programme or report, in which a sea-coast light is recommended by the light-house board for this vicinity.

B—No. 35.

Letter from Captain Oliver Eldridge.

SHIP ROSCIUS, (at sea,)

January 16, 1852.

SIR : Your communication of the 29th of May last, relative to the light-houses, &c., &c., of the United States, was only received a short time since, and this must be my excuse for not replying to it sooner.

In reply to your first question, "How many passages do I make per annum, and between what ports?" I make six passages per annum between New York and Liverpool, England. "What do I run for on those passages?" I usually run for and make, on our own coast, Sandy Hook, Highlands of Navesink, and Fire island lights; Cape Clear, Old Head of Kinsale, Saltees (light vessel) and Tuskar lights, on the Irish coast; Bardsey, South Stack, Skerries, Point Linas, and Northwest light-ship (off Liverpool) on the English coast. When we go out or in the north channel, as we do frequently, we make the following lights: Calf-of-Man, Mull of Galway, Cornwall, Sanda Isle, Mull of Cantine, Rhins of Islay, and sometimes Skerryvore, on the English and Scotch coasts; and on the Irish coast, South Rock, Copeland island, Maidens, Innistrahul, and Tory island.

Your next question, "What the location and character of the foreign lights, the description of their apparatus, their comparative brilliancy, range and steadiness, and certainty of being lighted between sunset and sunrise, to those of the United States, in positions of equal or greater importance to our navigation?" Their location I have before stated; their apparatus is of the most approved kind, and they are all, without exception, good lights; and I have never known of an instance of their not being lighted when they should be; and taken together, I think them superior to those of the United States. Your next: "What the general condition of the lights of this country compared to those of Great Britain, France, and the West Indies, with reference to usefulness, range and brilliancy?" I think the general condition of the lights of this country not so good as those of Great Britain; I am but little acquainted with those of France and the West Indies.

Your next: "What the best sea-coast lights of this country, and how do they compare with those of other countries as to range and brilliancy?" The best lights that I have ever seen on our coast are the Highlands of

Navesink, (Fesnel lenses) and Boston outer station, (parabolic reflectors—made in London,) and they will compare favorably with the English lights.

Your next: "How do the lights on the coast of the United States compare with those of Europe in their characteristic distinctions?" Those that I have seen compare favorably.

Your next: "How do the light-vessels on the coast of the United States compare with those of Great Britain as to usefulness, certainty of position, brilliancy, and range of light?" Unfavorably. Your next: "How does the system of buoys on the coast of the United States, and also that of land-marks, compare with those of Great Britain?" Very unfavorably.

In reply to your closing remarks, I would suggest that a light-ship be moored off the South shoal of Nantucket. I think it would be the means of saving many lives, and valuable property. I would mention that the light-ship off the Saltees island, Ireland, is in a situation equally as much exposed, and would recommend that one be moored off Nantucket in the same manner. The end of the cable that is attached to the vessel is secured by elliptical springs, which prevent any sudden jerks. I would also suggest that a beacon be erected on the south side of Long Island, for the land for many miles in extent has the same appearance, so that pilots are often deceived. A large bell-buoy placed near the bar at Sandy Hook, would be of great service to enable ships to know their whereabouts during a fog, and I would suggest that the harbor of New York be better buoyed. The English system I think much better.

Your obedient servant,

OLIVER ELDRIDGE.

To the SECRETARY OF THE LIGHT-HOUSE BOARD.

NOTE.—The remarks in parentheses are the board's.

B—No. 36.

Letter from Captain F. Hallet, commanding ship "Queen of the West."

NEW YORK, January 12, 1852.

SIR: I am engaged in the trade between New York and Liverpool, and make three or four voyages per annum.

The lights run for and passed are as enumerated by Captain Comstock, of the steamer Baltic, in his communication to you dated January 8, 1852; and I agree with him in his description of them.

I also deem it very important that a large and strong light-ship should be placed near the New South Shoal, off Nantucket; and think that the bay and harbor of New York require to be better lighted and buoyed, as, in its present state, it is unsafe for even vessels of even moderate draught to enter at night.

Very respectfully, your obedient servant,

F. HALLET.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to Light-house Board.

B—No. 37.

Letter from Captain J. J. Comstock, commanding United States mail steamship "Baltic."

NEW YORK, January 12, 1852.

SIR: In reply to your inquiry regarding lights, &c., with a view to lay before the Hon. Secretary of the Treasury such information as may be necessary to enable him more fully to improve their condition, I would respectfully submit the following:

I am engaged in the United States mail steam-service between New York and Liverpool, making from eight to ten voyages per annum. The lights run for, or usually sighted, on the English coast, through the Irish channel, are Cape Clear, Old Head of Kinsale, the Isle of Bally Cotton, Mine Head, Waterford, Saltees light-ship, Tuskar, &c., on the Irish coast; and the Smalls, St. David's, the Bishop, Bardsey, Holyhead, and the Skerries, Point Lynas, and others of less note, all of which are of the very best character, and so arranged in their various modes of revolving as to be distinctly observable and safely to be relied upon. Those passed through the North Channel, between Ireland and Scotland, are Tory Island, Innistrahul, Mull of Cantine, Mull of Galway, the Maidens, the Copelands, Calf-of-Man, and others of less importance. The lights in this channel are, in every respect, equal, if not superior, to those in the South Channel, for their great brilliancy and distinctive character. It is quite unnecessary to enumerate the lights on our own coast, as they are well known to the department; but, while they are in some respects good lights, I think there are none equal to the best English or French lights.

The light-ships, beacons, buoys, &c., on the English coasts and harbors, are very reliable, and in a greater degree superior to those of our own bays and harbors. There are many points where lights might be placed with great advantage to the safety of navigation, among which the South Shoal of Nantucket stands most conspicuous, and where a light-ship could safely be placed, if every care was taken as to size and strength, as well as in the proper equipment of the vessel. At some point on the south side of Long Island another light is also required. The harbor of New York requires and deserves immediate attention in its bay and approaches, as it is unsafe, and at night quite impossible to enter, with the numerous ships and steamers that are now daily entering the port.

Very respectfully,

JOS. J. COMSTOCK.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to Light-house Board.

B—No. 38.

Letter from Captain J. D. Wilson, commanding United States mail steamer "Empire City."

NEW YORK, July 15, 1851.

SIR: Your letter addressed to me, under date of 29th May, 1851, relative to light-houses and general observations on the route of the ship under my

command, was received last week, and I herewith submit the following remarks:

The "Empire City" performs a voyage hence to Chagres and back monthly, usually going through the Caycos passage; but a strong westerly current sometimes prevailing, sets the ship off her course, and we find it more convenient to go by the west end of Mariguanna, leaving Great and Little Herreagua on the port hand, as also St. Domingo; and thence to Chagres the course is SSW.; but the humidity of the atmosphere on approaching the coast, and the sameness of the land in the vicinity of Navy bay and the entrance of Chagres river, has led many navigators on a wild-goose chase to the westward, seeking their port of destination; when a light or tower on the point of Navy island, forming, as it does, one side of the finest harbor in the world, would prevent all such mistakes in future; and it is now becoming a point of great interest to our merchant marine, for, during the last year it has frequently occurred that thirty or forty sail of American vessels have been anchored at Navy bay at one time, thus demonstrating the importance of a light at that point, which is destined to be the great thoroughfare of all nations.

I will build, or cause to be built, a light-house *myself*, under the sanction of the government, with the privilege of collecting light-dues on vessels arriving at that port, and would consider it a capital investment, for I am quite sure that no charges would be paid with greater alacrity and cheerfulness by masters of vessels generally, than the trifling tax that would be necessary to impose upon each one to support a beacon that would guide the tempest-tossed mariner to a haven of security and rest.

The island of Manzanilla, or Navy island, has been surveyed and ceded by the government of New Grenada, and entirely appropriated for the use and benefit of the Panama Railroad Company, who would doubtless, for a small remuneration, sell the point required for public buildings; and I deem it one of the most important improvements now before the public of the United States, as hundreds of thousands of our fellow-citizens are constantly passing and repassing to and from our States and Territories of the west.

In returning from Chagres we have made it convenient to stop at Kingston, Jamaica, and on this route pass Morant Point light, on the east end of Jamaica, a superior light as compared with our own coast lights generally; but we have some, however, that will compare favorably with the best English lights. The Highland light on Navesink I have seen distinctly, bearing N. by W. $\frac{1}{2}$ W., over thirty miles from the ship's deck. The light-ship off Sandy Hook is not of much account, as the Highland light and Sandy Hook can be seen on approaching it from any point, long before it is discernable. It would be of service as a bell-boat, for then it would indicate the fair way in a snow-storm or foggy weather; for any person competent to command a ship, after making the light-boat and bringing it to bear SE. by S., and steer in NW. by N., will pass the bar in the best water, where he can anchor or round the Hook and anchor in the Horse Shoe on good holding-ground, secure from easterly or southerly winds. The light-boat has kept her position very well for the last two years.

The coast of the United States, so far as I am acquainted, will compare favorably with any country of Europe as to buoys and beacons, but our lights generally are inferior to those on the English coast. The English government has lighted one of our great thoroughfares to the south, which has done them infinite credit. I allude to the route by the "Hole in the

Wall," on which is a good light ; as also on Gunkey and the Double-Headed Shot Keys, where probably fifty of our vessels pass to one of theirs ; and it would afford me pleasure to learn that our government would reciprocate to a small extent, by placing a good light at the entrance of Navy bay.

Very respectfully, your obedient servant,
J. D. WILSON.

To Lieut. T. A. JENKINS, U. S. N.,
Secretary to Light-house Board.

The undersigned having read and approved of Captain J. D. Wilson's report, fully agree with him as to the importance of a light at Navy bay.

H. J. HARTSTENE, U. S. N.,
Captain United States Mail Steamer Falcon.

H. W. JOHNSON,
Captain Steamer Prometheus.

J. TANNER,
Captain Steamer Crescent City.

D. D. PORTER, U. S. N.,
Captain Steamer Georgia.

B—No. 39.

Letter from Captain J. D. Blanchard, commanding the ship "C. C. Dover," of Boston.

BOSTON, January 31, 1852.

SIR: I received your letter of May 29, 1851, on my arrival at this port from St. Petersburg, and improve this my first leisure to answer it, as fully as in my power.

1. My voyages are somewhat promiscuous, but are generally confined to ports in the Gulf of Mexico, the island of Cuba, Great Britain, France, and the north of Europe ; thence back to some northern port in the United States ; say about six passages per annum.

2. When bound from a northern port in the United States, to Cuba or the Gulf of Mexico, I first run for the "Hole in the Wall" light, on the island of Abaco, which is a good revolving light ; we have few superior to it on our coast. We next run for Berry island, where there is no light, but where one is needed. Should the ship be drawing thirteen feet of water or more, we run for the Great Isaacs, on which a good light is very much needed. This light would be very useful to vessels bound out of the gulf, as well as to those bound southward. From the Great Isaacs we navigate along the western edge of the Great Bahama bank, as far south as the Orange Keys, where a light is also very much needed. This light would be equally useful to vessels crossing the bank, or taking the course I have described. We next run for Dog Rocks, on the northeast point of Salt Key bank, where it is desirable there should be a light. If we cannot fall in with Dog Rocks by daylight from Orange Keys, we steer for Double-Headed Shot Keys, where there is an excellent light. Bound to Havana or Matanzas, we run down the coast for the Moro, at the entrance of the harbor of Havana, on which is a very superior light, surpassed by none that I have

seen, except that on Cape Grisnez, on the northern coast of France. Should we be bound to a port in the northern or eastern part of the Gulf of Mexico, our course from the Double-Headed Shot Keys, if by daylight, is for the Florida coast, which we endeavor to fall in with about Viper Key, where I think it very necessary there should be a light on the reef. If we cannot fall in with the Florida coast by daylight, we are obliged to steer up the gulf, stemming the whole force of the current until daylight, as there is no light on the Florida coast between the Tortugas and Cape Canaveral, safe to run for in the night. You are perhaps aware that this is a very dangerous part of our coast, and what few lights we have had there, have been very inferior. I do not know a ship-master who would venture to run for one of them in the night. The Tortugas light is a tolerably good one, and so are the lights in the Gulf of Mexico, as far west as New Orleans. I do not feel competent to suggest any alterations in them; nor do I know any localities west of the Tortugas where more lights are needed. Bound to New York from a southern port, we run for Barnegat or the Highlands of Navesink, being governed by the wind, as to which, if from a port in Europe, we should run for the Navesink lights. Bound into Boston bay from a southern port, we strike soundings to the southwest of the South shoal of Nantucket, off which a good light is much needed. After rounding the South shoal, our course is for the Cape Cod lights. If bound to Boston, since the destruction of the Minot's ledge light, we steer for Boston light. It is very important that the light-house should be rebuilt, either on Minot's ledge or on a ledge three or four hundred feet inside of it, which presents a much better surface for a light-house than does the rock on which the former one was built. Coming from Europe, we should be governed by the wind, whether to steer for Cape Cod or Cape Ann, on both of which are excellent lights. If bound to Portland, Maine, we run for Cape Elizabeth, where there are two excellent lights. A light is very much needed on Hog Island ledge, Portland harbor, to guide vessels in going up to the city.

3. The location and character of the lights on the coast of Great Britain are familiar to me, and I think them superior to those of any other country that I have visited. I know nothing of the apparatus employed in any foreign light. Their comparative ranges, steadiness, and certainty of being lighted, are quite equal to those of the United States.

4. The northern coast of the United States, say from the capes of the Delaware to the island of Seguin, at the mouth of the Kennebec, I consider to be as well lighted as the coast of Great Britain or the northern coast of France.

5. Boston and Cape Cod lights are the most brilliant of any that I am familiar with on this coast, and are fully equal to any on the coast of Great Britain, France, or the West Indies, with the exception of the Cape Grisnez light, on the northern coast of France, mentioned above, and which I think the best light I have ever seen. The best lights in Great Britain are the Scilly Islands, the Lizard, Portland, Beechy Head, Dungeness, South Foreland, Cape Clear, Holyhead, and Skerries; (on the eastern coast of England I am not so much acquainted.) On the coast of France the best lights are Cape Grisnez, Calais, Ushant, and Cordouan. Our next best lights are Cape Ann, the Highlands of Navesink, and Sandy Hook, which I think are all the lights we have which will compare with the foreign lights mentioned above.

6. The United States lights compare favorably with foreign lights as to characteristic distinctions.

7. The light-vessels of the United States compare miserably in regard to certainty of position, and unfavorably in regard to brilliancy, with foreign ones. The light-ships on the coast of the United States would be quite as useful as those on the coast of Great Britain, if their position could be depended upon, and the lights were as brilliant.

8. The system of buoys, beacons, and sea-marks of the United States, compares unfavorably with that of Great Britain.

I think if our government had been aware of the urgent necessity which exists for good lights on the Florida coast, they would not have been so long neglected.

In regard to those lights needed on the Bahama banks, would it not be well for our government to call the attention of the British government to the subject?

The large proportion (probably three-fourths) of the shipping navigating about the Bahama banks is American, and much American property is lost there for want of lights. On my last passage from this port to Havana, in May last, I had the misfortune to get on shore on the Moselle shoal, on the western edge of the bank, which accident cost upwards of \$15,000.

Had there been a light on the Great Isaac, the probability is, that I would not have got on shore.

Your most obedient servant,

J. D. BLANCHARD.

Lieut. THORNTON A. JENKINS, U. S. N.,

Secretary to Light-house Board, Washington, D. C.

B—No. 40.

UNITED STATES LIGHT-SHIP, OFF SANDY HOOK,
August 17, 1851.

SIR: According to your directions, I shall endeavor to answer the following questions to the best of my knowledge. I have looked over the old log-books, which are very much defaced, and some parts of them missing, owing, I suppose, to the dampness of the ship.

Q. What are the dimensions and tonnage?

A. The ship's length is 98 feet 6 inches; her breadth of beam, 24 feet 6 inches; height between decks, 6 feet 11 inches; from spar-deck to keel, 12 feet; her tonnage by register is 230 tons.

Q. What is her location?

A. She is moored in lat. $48^{\circ} 26' 30''$ N., and long. $73^{\circ} 55'$ W. The Highland lights bearing, by compass, WSW., distant $6\frac{1}{2}$ miles; Sandy Hook light W. by N., distant $6\frac{1}{2}$ miles; Fort Tompkin's light NW. $\frac{1}{2}$ N., distant 13 miles.

Q. What number of lights; how produced; if with reflectors?

A. There are two lanterns, each containing 48 panes of glass, the panes measuring 13 by $8\frac{1}{2}$ inches; the lanterns are 4 feet in height, exclusive of the roof, which is sloping, with no other reflectors than keeping the inside of the roof bright; the whole of the frames and roof are copper, and have four sides, measuring 3 feet on each side; the lights are produced by sperm

oil in compass lamps, each lantern containing one lamp, and each lamp containing nine wicks, one flat wick in the centre and eight round small wicks in a circle round the lamp, enclosing the centre one, and the lights are visible from every point of the compass.

Q. How is the ship moored ?

A. As per enclosed diagram.

Q. What is the height of the lights above the level of the sea ?

A. The forward light is 37 feet, and the main light is $48\frac{1}{2}$ feet above the level of the sea.

Q. When was the ship built ?

A. I do not know.

Q. When was she placed in her present position ?

A. I do not know exactly, but think some time between the years 1836 and 1837.

Q. How often has she broken adrift ?

A. As many as eighteen times, by the log.

Q. What time elapsed between her breaking adrift and returning to her station ?

A. In 1841, she was four months and seven days off of her station; at other times, varying from four to five weeks; she has broken away once since I commanded her—that was in March, 1850. She then underwent repairs, and was absent from her station about a month. In 1838 she broke adrift three times during the year, and was off that station in all that year about eight months.

Q. What number of persons is employed on board the ship, and what is their pay and emoluments ?

A. The whole number of persons employed is twelve: the captain at a salary of \$700 per annum, without any emoluments; the first officer at \$30 per month, and one ration of 20 cents per day; cook and steward, one man performing both duties, at \$18 per month; six able-bodied seamen at \$15, and three ordinary at \$12, per month, with one ration each of 20 cents per day, and 20 cents per month deducted from each for hospital money.

Q. At what distance can your lights be seen under ordinary circumstances ?

A. Under ordinary circumstances four miles; when very clear, perhaps six miles.

Q. Under what regulation and discipline is the ship kept ?

A. The same as on board of sea-going vessels, usually; always keeping in view the Secretary's circular. The lamps are lighted at sundown and extinguished at sunrise. The lamps are always trimmed every four hours, and oftener if necessary; a constant watch is kept on deck, night and day, and the bell is constantly tolled in thick weather; the time is struck by the bell every half hour during the twenty-four hours. The deck and the ship outside are washed every morning, and twice a week the lower deck and cabin are washed, summer and winter. The ship and her boats are kept in as good order as possible. The berth-deck and oil-room are whitewashed twice a year; the hold and ballast are cleaned and whitewashed in the spring and fall of each year; the ballast turned over as often as necessary to keep it in good order. The ship is sounded or pumped out every morning. The wind-sails and awning set always when necessary, and the riding chain hove in and examined, and new pins inserted in the shackle bolts, as

often as practicable. I believe, sir, this letter contains all the information I can give you, that will be of any service.

I am, with the greatest respect, your obedient servant,

HENRY P. LUNT, *Master.*

TO JAMES COGGESHALL, Esq.,

Superintendent of Light-ships, &c., New York.

Letter from Captain John Willard, commanding the packet-ship William Tell, from New York.

SHIP WILLIAM TELL, (*at sea.*)

SIR: Yours of 29th May last, asking information respecting light-houses, buoys, beacons, sea-marks, &c., &c., was handed me by Mr. G. Manning at New York, some time since.

In answer to your first question, I will state that I command the New York and Havre packet-ship William Tell; that I make three voyages in each year, viz: three eastward and three westward.

Second. In approaching the English channel I always run for the Scilly islands, if the weather be clear, and endeavor to make them; or if it be in the night, to make the light, which can be seen from the deck of a ship at the distance of about eighteen miles.

Having passed eastward of Scilly, I continue up the English coast; sight the Lizards (two lights) and Start point, then haul southeastward and endeavor to make the Casquets, Cape La Hague, and Cape Barfleur lights, on the French coast. All these lights I consider to be good; they can be seen at night, in clear weather, from fifteen to eighteen miles from a ship's deck.

The new light at Cape Barfleur is revolving and of great brilliancy, and is one of the best, if not the *very best* I have seen in any part of the world. The light-house stands upon a low point of land, but the building is very high. I am told by the French pilots that the light is 365 feet (French) above the level of the sea. I have frequently seen it from twenty-two to twenty-five miles from the deck.

Cape La Heve (two lights) are also very good. On a very clear night both Barfleur and La Heve lights can be seen at the same time, when between them, from a ship's fore yard; their distance from each other is about fifty-four miles.

As regards the description of apparatus employed, number of lamps, size of reflectors, &c., &c., I am unable to give any information, being unacquainted with the subject.

In drawing a comparison of the lights, generally, of the United States coast, with those of Europe, that I have seen, I am of opinion that the latter are the best; that they can be seen at a greater distance; that they are lighted at a given time, according to the season of the year; trimmed and attended to throughout the night with greater care and punctuality.

I may, perhaps, make an exception to this statement—that of the lights upon the Highlands of Navesink* at New York, and also the Boston light† situated upon the Great Brewster; both of these are good.

Notes by the Light-house Board.

* Lens lights.

† Boston light, referred to, is fitted with 21-inch parabolic reflectors, made by W. C. Wilkins of London, and imported by Commodore Perry, U. S. N. This is the only light on the coast fitted with reflectors made out of the United States.

The lights, generally, upon the coast of Europe are placed in more elevated positions than those on our own coasts, which may partly account for their being seen at greater distances.

Some of the lights upon our southern coast are bad, especially that of Tortugas, which should be, according to its important situation, one of the first magnitude.

On the subject of buoys, beacons, sea-marks, &c., &c., I am of opinion that our harbors and channels are very indifferently marked out; whereas, in Europe great attention is given to this subject.

In the latter country the sides of the channels are distinctly marked by can-buoys, painted red, being placed on one side of the channel, and black on the other, regularly numbered, so that it is almost impossible that they should be mistaken. When there is a bank, spit, or any sudden turn in the channel, it is denoted by a larger buoy, with a perch or pole attached to it.

I will remark that great inattention is paid to the buoys in the harbor of New York. The ice during the winter frequently carries them away, or moves them from their proper places, and it is a long time before they are replaced.

Respectfully, your obedient servant,

JOHN WILLARD.

Lieut. T. A. JENKINS,

Secretary to the Light-house Board, Washington, D. C.

PHILADELPHIA, *April, 1852.*

DEAR SIR: Permit me, through you, to make known a few facts relative to occurrences in the neighborhood of the Delaware bay, showing the necessity for an alteration to be made in the light on Cape Henlopen.

A number of vessels have been stranded and lost in consequence of the cape light having been mistaken for the light-ship on Five-fathom bank. The ship I now command was stranded from that cause. On my last two voyages the light has had the appearance of showing *two* lights. With good pilots on board, we have been unable to discover the difference, until we have made the beacon-light. On my last voyage, after making the light, (having had no observations for two days,) the officer on deck was asked to look at the light, who at once replied, "It is the light-ship; I can see two lights distinctly." The first officer being called, looked with, and without, the glass. "That is the light-ship; we shall be in with the cape by daylight," was his reply. (I merely mention this to show how persons may be deceived.*)

You will perceive, by reference to the chart, that the depth of water is no guide. When there is a bank of clouds to the westward, the light reflects and appears to strike the sand or water at the base of the light-house, which causes the appearance of two lights. This light being one of the poorest of fixed lights, and becoming more important every day, I would respectfully call your attention to the necessity of an alteration being made;

* This deceptive appearance of two lights, where there is only one, can only be accounted for upon the supposition that the reflectors are not placed properly on the frame to transmit the rays of light in parallel beams to the horizon.—*SECRETARY to Light-house Board.*

Cape May light being of no use to vessels of heavy draught approaching the entrance of this bay.

Our present packet-ships, drawing from twenty to twenty-two feet of water, must keep well to the southward of the Five-fathom bank, and run for Cape Henlopen light.

If this were made a flashing light—say every five or ten seconds—it could not be mistaken for another. In conversation with a number of masters, pilots, and others, they suggest that Cape Henlopen light should be made a revolving, and Cape May a fixed light; which would answer every purpose, and could be done at a small expenditure.

I would also call the attention of the board to the necessity of a bell-buoy being placed upon the point of the “Overfalls,” as a guide to pilots and others in thick weather, both as a leading mark to the breakwater and to lead up the bay to a safe anchorage, for ships of heavy draught.

I remain your obedient servant,

E. TURLEY,

Master of packet-ship “Tuscarora,” of Philadelphia.

Lieutenant T. A. JENKINS, U. S. N.,

Secretary Light-house Board, Washington, D. C.

P. S.—There has recently been erected on Bally Cotton island, (north-east of Cork, Ireland,) a flash-light, which appears to throw up a jet of flame, and can be seen at a distance of thirty-five miles.

APPENDIX C—Nos. 1 to 20.

LETTERS FROM LIGHT-HOUSE BOARD AND REPLIES FROM GENERAL SUPERINTENDENT OF LIGHTS, COLLECTOR OF THE CUSTOMS AT BOSTON, AND THE MASTER OF THE SUPPLY-VESSEL, &c.

OFFICE LIGHT-HOUSE BOARD,

May 24, 1851.

SIR: I am instructed by this board to address a communication to the Treasury Department, asking for information from the proper officer in relation to the present system of construction, illumination, inspection and superintendence of the lights, &c., of the United States, and have respectfully to request that the necessary directions may be given to obtain the desired information.

CLASSIFICATION.

What is the present system of classification of lights in the United States? What number of the different classes? By what system or rule are the classes determined with reference to power or intensity; number of reflectors and burners; size of reflectors and burners, or geographical position?

What number of lights are there on the seacoast classed as first order, or class lights? What the diameter of the burners? What the diameter of the reflectors? What number of lamps and reflectors of the largest sizes for a light embracing the whole horizon, three-fourths, one-half, and less arcs of the horizon, in each of these lanterns?

Please furnish a list of the light-houses at present existing in the United

States, in each separate class respectively, and also a list of those commenced but unfinished.

DISTINGUISHING CHARACTERISTICS.

What modes of distinction have been employed hitherto, and what at present? Please furnish a list of lights, with their different distinctions. What has been the result of experience and trials of the different modes of distinguishing seacoast and other lights, with reference to economy and efficiency, such as single, double, and triple fixed lights; two fixed lights in one tower, one above the other, white or colored; single fixed and revolving or other movable light, in towers adjacent to each other; single, revolving, flashing and intermitting lights, colored lights, white and colored combined in separate towers, and a beam of partly red and partly white light, transmitted to the horizon from the same burner or lens, and the means employed to accomplish it? What colors are employed as distinctions in the lights of the United States? Please specify the number of colored lights now existing, and the different colors employed.

How are the colored lights produced? Are the tubes or chimneys white or colored glass for colored lights?

What means are employed to prevent loss of light through colored media by absorption?

POSITIONS OF LIGHT-HOUSES AND LIGHT-VESSELS.

What means are employed to ascertain the proper positions for light-houses and light-vessels? By whom are such positions selected, and by whom are the persons designated for this duty appointed?

By whom are the sites for light-houses selected and their use obtained in special cases?

CONSTRUCTION, PLANS AND DRAWINGS.

How are plans for towers, dwellings, light-vessels and beacons procured; under whose direction and by whom approved or adopted?

Copies of specifications and working-drawings for special and general cases, or for the several classes of towers, are requested.

ILLUMINATION, &C., &C.

The illuminating apparatus, lanterns, machinery for movable lights, and other accessories—how determined upon; by whom; how procured; by whom selected and tested as to quality of material, perfection of shape, pattern and workmanship; by whom placed in the towers; by whom superintended while being fitted or placed in position, and by whom and to whom reported ready for use?

What number of lens or Fresnel lights are there in the United States at present? Please give the names of the localities, class of the lights and number of keepers to each, with the dates at which they were respectively lighted for the use of mariners. How often have these lights been reported out when they should have been lighted? How often have they gone out at night since they were lighted? The causes which produced the extinc-

tion, and any remarks that may be applicable to the case. What is the annual average expense of keeping the Carcel or French mechanical lamps used in the lens light, in repairs? How often do they require renewing? By whose direction are the repairs made upon the lamps of the lens lights?

Have the hydraulic or pneumatic lamps been introduced into the lens lights in the United States? Is there any objection to their use in localities adapted to them? What difficulties have been encountered at Navesink, in the management of the lens lights?

How are the reflectors and lamps placed on the frames?

Please specify in detail what number of lights, other than seacoast lights, (with reflectors,) including beacons, are used as leading marks in the vicinity of anchorages.

By whom, and upon what principle, are the reflectors in general use in the lights of the United States manufactured?

What is the proportion of silver to the pound avoirdupois of copper, used in the manufacture of the first, second, third, and fourth qualities of reflectors in use in our lights, and what the cost of each size and quality in use?

Are there any reflectors in use of an inferior quality, such as heavily or thinly plated ones? If any, what is their cost, specifying sizes, and how long do they last without being re-silvered?

What means are employed to secure the most perfect form in the reflectors? By whom tested, with reference to form and finish?

What description of lamps are in general use, and what the exceptions? What the diameter of the burners in most general use? Of what materials are they constructed? Are the burners tipped with silver to prevent rapid decay from the action of the flames, or what other means are employed to insure the greatest durability possible?

How, where, and by whom are the lamps placed in the foci of the reflectors, and the whole placed on the frame? What is the general rule or plan for placing the reflectors, by which to insure the transmission to the horizon of the greatest amount of light? By whom inspected? By whom and to whom reported prior to lighting?

What is the cost of the best 21-inch reflectors, with the best lamps in use attached? What proportion of the two metals? How long will they last and transmit the light, without unusual loss from deterioration produced by cleaning? How are the lamps and reflectors attached? What precautions observed in their fabrication, to prevent their getting out of adjustment by being handled by the keepers in cleaning them?

Have any of the lamps with reflectors known in England and Scotland as Mr. Alan Stevenson's pattern, been introduced into our light-houses?

What illuminating apparatus is used on board of our light-vessels?

Are Argand burners and lamps fitted on gimbals in use on board of our light-vessels? What description of apparatus is used in our light-vessels? Please describe it in detail, and specify the amount of oil consumed per annum. How long will the burners to the best lamps in use remain without requiring repairs, and how long without renewing?

What is the average annual expense of repairs per lamp (reflector lights) for the lamp alone? What the annual cost per lamp and reflector for polishing materials, buff-skins, cleaning-rags, &c., &c.? What is the average number of gallons of oil consumed per lamp per annum? Specify particular lights, and the diameter of the burners; the average number of hours each lamp was kept burning per annum.

SUPPLIES, &C.

By whom are the wants of lights supplied? How often are the lights visited, for the purpose of furnishing oil and other requisites? Who determines the wants of the lights, the quantity and quality of the oil to be delivered? What tests employed to insure a good quality, and by whom is the oil tested? By whom are the wicks, tube-glasses, buff-skins, glass, and other accessories procured, inspected, and delivered.

What is the established system of internal economy for towers and buildings, such as painting, whitewashing, repairs, &c.? What system of alarm-signals is employed in foggy or hazy weather? What is the mode of relief for the shipwrecked, at or near light-houses? How and where are the oils and other supplies kept in the light-houses? Are there special oil-cellar in each tower? Any regard paid to the subject of keeping as nearly an equable temperature in the places appropriated for oil as possible? Of what materials are the tanks or other vessels used for keeping oil made? What is considered the most economical and safest means of keeping oil? Do losses often occur from leakage?

LANTERNS, GLAZING, &C.

Of what materials are the lanterns of the light-houses in the United States constructed? Please specify exceptions to the general rule.

What would be the difference of first cost of lanterns constructed of bronze, (gun-metal) or ordinary iron, taking the same class or dimensions for each description of material in comparison? Are there, or not, many advantages in the use of bronze over that of any other metal for this purpose, especially with reference to repair, painting, and, finally, to lightness of sashes or astragals, by which much less light is absorbed and obstructed than from heavier sashes or astragals?

What description of glass is used for lanterns—French, English, or American plate-glass, or common glass?

What are the usual dimensions of the glass for lanterns of seacoast lights? What the largest sizes, and what the smallest, for all lights?

What the sizes of the sashes or astragals?

Are the astragals horizontal or diagonal? How is the glass placed in the lanterns—by glazing, or otherwise? Are the lanterns kept painted in the interior; and of what color? How often painted, and under what inspection? What precautions are taken to enable the keepers to replace broken panes of glass without delay? Are the necessary materials kept at hand for this purpose?

What system of ventilation is in use—a general or varied system? Please describe each mode by which a proper ventilation, and as perfect combustion as may be, is obtained. Have any of Professor Faraday's ventilating tubes been introduced into the light-houses of the United States?

ATTENDANCE UPON THE LIGHTS, &C., TO SECURE EFFICIENCY, CERTAINTY, AND CLEANLINESS.

How are the keepers appointed? How many to each light? Specify exceptions to general rule as to number to each light. Are keepers in-

structed in their duties, previous to entering upon them? For how long a period, where, and by whom?

Are keepers supplied with printed or manuscript detailed instructions, to guide them in the performance of the various duties of lighting and extinguishing lights, fitting wicks, filling lamps, trimming, cleaning, keeping the flame in the proper focus of the reflectors and at its normal height; times for executing the different duties during the day; cleaning reflectors; cleaning and keeping machinery for movable lights in order; best means of getting ice and snow off the glass of the lantern, dampness off the reflectors before lighting up, and using the ventilators, to insure perfect combustion without producing unsteady lights? If any in printed form, where ordered to be placed in the towers, lanterns, and dwellings, to attract the attention of keepers and assistants? Copies of all instructions for inspectors—those charged with the delivery of oil and all other supplies, and for keepers and assistants, are requested.

How often are the towers painted or whitewashed outside and inside? By whose order for special times, and to whom reported when completed? By whom inspected, and reported if not properly attended?

What distinguishing marks are employed to guide mariners by day—by different colors, stripes, squares, flags, balls, &c.? Please state the number and names of towers thus distinguished, and the distinction employed at each.

How are alarm signals made in foggy and hazy weather—by machinery, natural agencies, or by hand? Specify in detail, as far as may be practicable, and enumerate each case in the United States.

CONSTRUCTION.

Is there any general system of construction for special localities, by which each locality or description of locality may be said to be adapted to a particular description of material for foundations and superstructures? Please give in detail the modes employed in general, specifying the exceptions by name and location. How is the kind of tower for special localities determined; by whom the working-drawings and specifications, upon which the contracts are based, made; under whose authority and direction, and by whom approved?

Are towers for lights and beacons built in general by contract, embracing the entire work—by contract for the materials, and the work executed by day labor, or by purchase in the open market and day labor? Please state objections or advantages of each separate mode. By whom is the work superintended while under construction? By whom are the materials inspected before being received, and to whom reported if not of good quality? If by contract, please state in detail the various means employed to insure a faithful execution of the work.

Are conductors attached to light-house towers and to the masts of light-vessels? If any, what instructions are given in relation to placing them?

What means are employed to restore impaired or threatened foundations to light-houses and beacons? By whom are examinations made; to whom the results reported? How are plans and estimates, and by whom, made; how contracted for and superintended? These include sea-walls, breaches, drift-sand, undermining by unusual tides or heavy gales, and such like casualties.

How are repairs in general to towers, buildings, sea-walls, &c. &c., made;

how the necessity ascertained for making repairs; to whom confided; under what limitations and restrictions, as to character, plan, and expense?

LIGHT-VESSELS, BUOYS AND SEA-MARKS.

How are light-vessels procured? What rule obtains in regard to models, internal arrangements, lighting-apparatus, &c.? What length of time, on an average, will a light-boat last, and what the average annual amount for repairs in the most exposed positions, and what for those in sounds, bays, rivers, &c.? What the first cost per ton of light-vessels? How many persons are employed on board the light-vessels in the most exposed situations, and in the least exposed ones? Please specify the rates and amounts of pay and subsistence to each individual, including every item of allowance. How often are light-boats removed for renovation and repair? What number of extra vessels are kept to replace those driven from their moorings, and where kept in readiness for service? Which light-boats are kept at their moorings during the entire year; which removed; when and where replaced? How are light-vessels and buoys moored, and by whom? Please describe the different kinds of moorings, weights, sizes of chains, &c. &c.? How often are moorings of light-vessels examined as a security against damage from gales, and by whom? How often renewed as a general rule? Is there any system of relief for the masters, mates, lamp-lighters, and crews of the light-vessels? Are the masters required to live on board, or can they delegate their authority to deputies? What class of persons is employed as masters of light-vessels—seamen, or others? What system of inspection, and by whom made; how often and to whom are reports made of good or bad condition?

Please furnish copies of printed or other instructions to masters and others charged with the light-vessels, and lights on board of them, in relation to the routine duties, examination of moorings, &c. &c.

MEANS EMPLOYED TO ASCERTAIN PROPER POSITIONS OF BUOYS, BEACONS, AND SEA-MARKS.

How are buoys placed; taken up for renovation and replaced; by whom and by whose order? How are buoys distinguished? What descriptions of buoys are in general use; size, shape, materials of which composed, &c. &c.? How is it ascertained when buoys have been carried away from their proper positions? What authority is required to have them replaced? How are buoys procured to mark positions known to be dangerous, arising from casualties or recent discoveries in hydrographic operations? Are buoys placed, under any circumstances, in new positions, without special appropriations or acts of Congress? Please furnish a correct descriptive list of beacons, (other than those lighted) buoys, and all descriptions of sea-marks, if in possession of the department; and if no such correct list exists, then specify the best mode by which it can be obtained.

How often and by whom are the localities of buoys visited to ascertain if they are in the proper positions, and how ascertained; by angles between known points and soundings, cross-bearings, or by what other means?

Who is authorized to change the established position of a buoy, placed to mark any channel or hidden danger, and when changed what means are employed to give notice of such change to mariners?

At what date are buoys raised in different localities, to prevent them from being carried away by ice; when replaced; by whom; by whose direction, and how made known to mariners?

How is the expenditure for placing, replacing, painting, numbering, and repairing buoys, made; by whom and under what limitations and restrictions to insure the faithful performance of the duties, and a rigid economy of money?

What number of tenders and boats, if any, are there attached to the light-house establishment?

Please give the names and locality of each, with the number of persons employed, and the specific duties assigned to each one of them, the first cost and annual expenses of them.

MISCELLANEOUS.

How are notices given to mariners, and how long a time in advance of the lighting or placing new lights and buoys, erecting beacons and other sea-marks, or extinguishing and changing old lights?

Are such notices published in the commercial papers, distributed at home and abroad; to whom and by whom, and what special means employed to insure a wide dissemination?

How many inspectors of lights, beacons, and buoys, and other aids to navigation, are there at present? Who besides the collectors of the customs perform this duty?

What number of persons are employed in connexion with the lights illuminated with gas, other than keepers and assistants? What number of gas-lights are there? What classes, and how do they compare in relative efficiency and economy with other lights? What number of employées, in addition to the usual number of keepers, are required for the gas-lights?

How many light-house districts are there, and how are they defined?

What amount is paid annually for commissions on expenditures and inspections, and to whom paid?

How often, under what rule, and in what manner, are inspections of lights, &c., made? What questions or series of questions are propounded by inspectors to keepers, and to whom are the results of these inspections reported for approval of good condition or remedy of defects?

All the information in the department in relation to the employment of gas, chemical lights, different oils, such as sperm (best winter-strained and summer) oil, other fish oil, lard oil freed from stearine, cotton-seed oil, rape-seed or colza oil, the various mixtures of the oil of turpentine and alcohol, and any other combustibles for illuminating light-houses, the notice of which has been brought to the department, is desired.

The board, with a view to the regulation of its movements, respectfully requests to be informed at about what period it may expect the information asked for in this communication.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,

President Light-house Board.

HON. THOMAS CORWIN,

Secretary of the Treasury, Washington, D. C.

C—No. 1.

TREASURY DEPARTMENT,
Fifth Auditor's Office, May 27, 1851.

SIR: I have had the honor to receive your letter of this day's date, enclosing one from the president of the board for examining light-houses, calling for a great variety of information, the most of which is contained in the reports and papers with which I furnished them since the date of their letter. There are other items of information called for by them, not yet furnished, which requires research; and I cannot, therefore, say with any precision when my answer can be sent to them; it will probably not be for two or three weeks. I shall be happy if I can prepare it sooner.

I have the honor to be, sir, very respectfully, your obedient servant,
 S. PLEASANTON.

Hon. THOMAS CORWIN,
Secretary of the Treasury.

C—No. 2.

TREASURY DEPARTMENT,
May 28, 1851.

SIR: Having referred your letter of the 26th instant to S. Pleasanton, esq., the general superintendent of the light-house establishment, I am advised by that officer that it will not be in his power to furnish all the information within the scope of your inquiries before two or three weeks.

A copy of his letter is herewith enclosed.

Very respectfully, your obedient servant,

THO. CORWIN,
Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,
President, &c. &c.

C—No. 3.

TREASURY DEPARTMENT,
June 7, 1851.

SIR: I herewith enclose a communication, under this date, from the Fifth Auditor, respecting the present state of the light-house establishment in the United States.

Very respectfully, your obedient servant,

THO. CORWIN,
Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,
President Light-house Board, Washington.

C—No. 4.

TREASURY DEPARTMENT, FIFTH AUDITOR'S OFFICE.

June 7, 1851.

SIR: I have had the honor to receive your letter of the 24th ultimo, enclosing one from Commodore Shubrick, president of the light-house board lately constituted, asking a variety of information in relation to our light-house establishment.

With the view to give the board the fullest information in my power, concerning our light-house establishment, I have thought it proper to recur to the first law upon the subject, passed 7th August, 1789, soon after the adoption of the constitution, and to detail what has been done under it.

This law authorized the Secretary of the Treasury "to rebuild, when necessary, and keep in good repair, the light-houses, beacons, buoys, and public piers, in the several States, and to furnish the same with all necessary supplies." This authority was afterwards transferred to the Commissioners of the Revenue, and to me in the year 1820. The law also authorized the Secretary to agree for the salaries, wages, or hire of the person or persons appointed by the President, for the superintendence of the same. Under this law the collectors of the customs the most convenient to the light-houses, without regard to their collection districts, were designated, first by the President, and afterwards by the Secretary of the Treasury, as superintendents of lights, &c., to act under the general head at the seat of government. They were appointed, as stated in some of the letters to them, "*as the natural guardians of the commerce of the country.*" They were allowed first 5 per cent., and afterwards $2\frac{1}{2}$ per cent. on their disbursements, limited by the law of 23d May, 1828, to \$400 per annum. Here is the system since the adoption of the constitution, which has prevailed in this country, for taking care of the light-houses, buoys, &c., at once simple, cheap, and effectual. The collectors having moneys in their hands, generally, with which to pay the expenses for which they were accountable under their custom-house bonds, no losses have been sustained on account of light-houses, by the government; and these officers, always intelligent and respectable men, have been found willing and even zealous in the discharge of their light-house duties, notwithstanding the inconsiderable compensation they received for it prior to the general appropriation act of the 30th September, 1850. By that act every collector whose compensation, as such, amounted to \$2,500 per annum, which comprised those charged with the greater part of the light-house duties, were cut off from all compensation whatever for those duties. How this may operate upon this valuable class of officers whose services are thus considered worthless, remains to be seen. The keepers' salaries were fixed by a law of May 23, 1828, at an average of \$400.

Under the direction of the general superintendent at the seat of government, these officers, when light-houses were authorized to be built in their respective districts, selected, with the aid of retired pilots and ship captains, the most suitable sites, purchased the land necessary for the buildings, obtained cessions of jurisdiction from the States, advertised for proposals or plans, furnished by the general superintendent, accepted the lowest bids, appointed suitable mechanics as overseers of the work, day by day as it progressed, and paid no part of the money until the overseers certified that it was well done. It is the duty of the superintendents, also, to visit all

the light-houses in their respective districts once a year, and report their condition and the conduct of the keepers to this office.

For convenience these plans comprised four classes of towers, viz : sixty-five feet, fifty feet, forty feet, and thirty feet high, the particular dimensions of all of which are mentioned in my reply to a speech of Mr. Profit, which will be found in the report of the Committee on Commerce, No. 8, page 75. There are four classes of reflectors also, viz : 14-inch, 16-inch, 18-inch, and 21-inch diameter, made in moulds or dies, in the best manner, and with which I have caused nearly all of the old light-houses to be fitted since the year 1840, and all the new light-houses which have since been built. A copy of the contract for making these reflectors, with lamps, chandeliers, &c., &c., at Boston, is herewith transmitted. The silver to be put on the reflectors is weighed, and the lamps and reflectors are fitted upon the chandeliers under the inspection of William A. Wellman, esq., an officer of long experience, and the assistant collector at Boston, before they are sent to the light-house for which they are wanted. They are then sent and fitted in the lanterns by a mechanic well acquainted with the subject. That the reflectors are a true parabola, I possess the certificates of Mr. R. H. Eddy, a civil engineer of distinction at Boston, and Mr. George F. Wilson, of Providence, Rhode Island, appended to a diagram of the reflector.

I have also within the last ten or twelve years substituted in most of the light-houses on the seaboard, new lanterns, with large French plate-glass, generally 16 by 28-inch panes, and sometimes much larger for the old lanterns, with thick sash and small panes of Boston glass, by which the lights probably have been as much improved as by the new reflectors. French plate-glass is used because all other changes color and becomes opaque by being exposed to the sun and salt air.

It must be apparent to all who reflect upon the subject, that I have had much inconvenience and difficulty to encounter from the frequent changes incidental to our form of government, in the light-house keepers, who for a time do not understand the management of their lamps, and consequently keep bad lights and waste much oil. So necessary is it that the lights should be in the hands of experienced keepers, that I have, in order to effect that object as far as possible, recommended, on the death of a keeper, that his widow, if steady and respectable, should be appointed to succeed him ; and in this way some thirty widows have been appointed.

The light-house board I hope will visit and examine all the lights from Maine to Louisiana, without which it will be impossible for them to do justice to the establishment. Having myself, some years ago, examined most of the lights from Cape Henry to Maine, and for a part of the distance taken Governor Davis of the Senate, and Mr. Bancroft, collector of Boston, with me, both of whom, as well as myself, found the lights generally in most excellent order, well attended to by the keepers, and satisfactory to navigators, (see House Doc. No. 62, 1st session 28th Congress,) and having from time to time since received favorable reports from the superintendents and other persons whom I have sent to examine them, I feel not the smallest doubt that the board will, as a whole, find cause to commend the establishment. That defects will be found in some cases may be expected. One of these is known to me, but it has not been in my power either to prevent or to correct it. It is the building of too many lights in some places on the eastern coast ; and of this evil, a visit by the board would enable them to recommend to Congress the correction.

To facilitate the inquiries of the board in its examination of the lights, I have caused to be copied and laid before it a list of the several collectors acting as superintendents, the light-houses, &c., under each, with the names and salaries of the keepers of the light-houses and light-vessels.

French Lenses.

We have but three light-houses fitted up with lenses made in France. There are two at the Navesinks, near Sandy Hook, of the first and second orders—one stationary, and the other revolving, with flashes. They are attended by five keepers—a principal at \$600, and four assistants at \$360 each. In France the same number could be employed for about \$600. The two consume upon an average three gallons of oil per night.

The third is at Sankaty Head, on the island of Nantucket, and is a revolving light of the second order, exhibiting red and white flashes. A principal keeper here receives \$600, and two assistants at \$360 each. The lamps used in these lights are “Carcel,” made in France. The keeper at the Navesink, where they were first put in operation, being a machinist, was supplied with tools, with which to repair the lamps, of which he had one or two spare ones. These tools were handed over to his successor, so that there are no expenses found in the accounts for repairs. The lamps of the one at Sankaty Head have not been long enough in use to require repairs. At least there are no charges in the accounts for repairs.

Believing that if any of the lenses could be employed with advantage in any of our light-houses, it would be those of the third order, I recommended to Congress, through the Committee on Commerce, an appropriation for one of that order, to be placed on the inward light in Boston harbor, so that scientific and nautical men living in that city could examine it from time to time and determine its value. Congress, however, omitted to grant the appropriation. The letter from this office to the committee will be found in the report of the Committee on Commerce of the House of Representatives, No. 8, p. 39.

* * * * *

Oil and other materials for lighting.

All the oil, tube-glasses, wicks, buff-skins, tripoli, lamps and reflectors, and parts of lamps, and oil butts, are procured twice a year by the collector at Boston, by advertisement, and forwarded to the light-houses on the Atlantic coast, formerly by one vessel, but now by two vessels, beginning in the spring, at St. Mary's, in Georgia, and going eastward to Passamaquoddy. A lamp maker is taken on board for the purpose of repairing the lamps, for which he has every necessary material with him.

In the fall of the year the oil and other materials for maintaining the lights are procured in the same manner, and one of the vessels is despatched with them to supply the lights from St. Mary's to Louisiana inclusive. The captains of the vessels take the receipts of all the keepers for the oil and everything delivered, and forward them to this office. It is their duty also to report the state of the buildings and the apparatus.

The oil is inspected in the manner described by B. T. Congdon, inspector of oil at Boston, in a letter to the collector there, dated 16th December,

1845, written in reply to a complaint of bad oil on the lakes. A copy of the letter is annexed.

The oil and other things used for lighting on the lakes Erie, Huron, Michigan and Superior, are sent to Buffalo, taken on board of a vessel there by a general inspector of lights, who proceeds with them to all the light-houses, delivers what is proper at each, and takes and forwards the receipts of the keepers to this office. The vessel also carries a lamp maker, who makes all necessary repairs. Supplies for Lake Ontario are sent to the collector at Oswego, and those for Lake Champlain to Plattsburg, for distribution. The inspectors, as well as the collectors last named, report the condition of all the lights which they respectively examine, and all in season to have the repairs made before winter sets in.

The average consumption of oil on the Atlantic coast is thirty-five gallons per lamp per annum, which is supplied to each light-house; and as some keepers burn more and others less, the excess is made up from those which can spare it. On the lakes and on the North river, the lights are suspended whilst the navigation is closed by ice, and the consumption of oil there is about thirty gallons per lamp.

Besides the best sperm oil from head matter, which has always been used in our light-houses, I have made trial of a camphine, by Mr. Greenhough, at Boston, and lard oil, at Cleveland, in Ohio. The camphine afforded a beautiful light, but after the lapse of a few months it became decomposed, and was not fit for use. The lard oil burnt very well in warm weather, but as early as October it congealed, and the manufacturer himself, at whose instance it was tried, was satisfied that it would not answer for light-houses.

I was in hopes at one time to have found a suitable and cheap substitute for sperm oil in that from cotton-seed; for, having tried it in my family, I found it to burn very well when new, but, like all oils from vegetable substances, after a few months it became thick and unfit to burn. So with rape-seed oil, which is used in the French lights, and is supplied every three or four months, whilst the sperm oil will remain good for the space of a year. The freight for supplying our lights on the sea-board annually, is about \$9,000; and if rape-seed oil were used, it would have to be supplied four times a year, and this item of freight, therefore, would be enhanced to the sum of \$36,000. The rape-seed oil, too, must be imported, as I am not aware that any is made in this country for sale; and as it costs in France from ninety-three cents to one hundred cents a gallon, the freight and expenses on it would make the cost nearly as great as the best sperm oil, independently of the increased freight. Besides, it is stated in some of the parliamentary reports that one-sixth more of the colza or rape-seed oil is consumed in the same time. There is nothing in it, therefore, which should give it a preference over sperm oil, which, in my opinion, is the best material that can be used for producing lights in light-houses.

Floating lights.

Of these we have forty-one, stationed in the Delaware and Chesapeake bays, the sounds of North Carolina, and at different places at sea. They are in size from 72 tons to 400 tons, according to the situation at which they are placed. In their formation I have had the aid of some of the most intelligent and experienced ship-builders in the country. The mode of lighting

them has advantages over that adopted in the British service. Whilst their lantern is made to go around the mast, and is hoisted and lowered by a windlass, ours is made to run up and down between two masts by means of weights, and kept at the mast-head by them.

These lights, however, ought never to be adopted for any situation in which a light-house can be built for any reasonable sum, for they are not only driven from their moorings often when they are most wanted, but in the frequent and expensive repairs which they require, and in the large number of men necessarily kept on board of them, they are three or four times the annual expense of a light-house of the first class.

Buoys.

The buoys established by law are very numerous, and on many parts of the coast are attended and kept in their places with great difficulty and at considerable expense. Down to the year 1842 they were well attended in the waters leading to our principal cities by the revenue cutters, to the officers of which I gave a few hundred dollars annually, in addition to their ordinary pay, for this service.

But in that year all extra pay from every branch of service was cut off by law, and I consider it improper to ask the Secretary of the Treasury to exact this as a duty from those engaged in the cutter service. In the district of New York a vessel is owned by the department, and in the Delaware district one is hired, both of which perform this and other duties connected with the light-house department. In other districts proposals are invited in the public papers from pilots, and the contract for a year or two at a time is given to the lowest bidder, which, though unreasonable in some cases, we are obliged to accept. It may be mentioned that no buoy is procured and moored which is not authorized by law. When once authorized, they are replaced as often as necessary.

Gas-lights.

We have four of these lights in the Delaware bay, viz : Christiana creek, Reedy island, Cohanzey, and Egg island. One of them has been in use since 1841, and the other three for several years past. These lights would all be extinguished from three to six months in the year, if oil and oil lamps were not kept at each of them to continue the lights. The keepers were in the habit of suffering the furnaces and retorts to be burnt out before they gave notice to the superintendent of the necessity of supplying new ones, and to provide and put these up required several months. In the mean time, to continue the lights, lamps with oil had to be kept at the light-houses and resorted to. I then ordered a double set of furnaces and retorts at each light-house, in order that one set might be used whilst the other was undergoing repairs; and this produced no improvement, as both sets were burnt out before they gave the necessary notice for new ones. There is room to believe that the keepers were averse to making and burning gas, but preferred the oil lamps. The superintendent consequently had orders, some time ago, to notify the respective keepers that if notice was not given by them in season, to keep the gas-works in repair, it would be cause for removal. What effect this may have is yet to be seen. With ordinary keepers, although the gas from rosin is excessively cheap, it is not advisable,

in my opinion, to attempt the use of gas in any more of our light-houses; and to employ scientific men to attend them, would occasion an expense out of all proportion to the benefits to be derived from them.

We have one light-house at Portland, on Lake Erie, lighted with natural gas, carried a distance of two miles in pipes to the tower; and even here we are obliged to keep oil and lamps, as water frequently collects in the pipes, over which the gas will not pass; and whilst they are taken up and freed from water, oil light has to be used. We have a contract for supplying this gas at the annual cost of the oil which would be required, if lighted with that material.

* * * * *

Having heretofore shown that the cost of maintaining our light-houses annually does not exceed one-third of that of the English, and very little more than one-third of that of the Scotch and Irish, and that the cost of our buildings, on an average, very little exceeds the interest of a single year on the cost of the British and Scotch buildings, I refrain from saying anything further upon the subject at this time. The letter from Commodore Shubrick is herewith returned.

I have the honor to be, sir, respectfully, your obedient servant,

S. PLEASANTON.

The Hon. THOMAS CORWIN,
Secretary of the Treasury.

C—No. 5.

OFFICE LIGHT-HOUSE BOARD,
Washington, June 16, 1851.

SIR: The light-house board having decided that the reply of the Fifth Auditor of the 7th instant, to the communication of the board of the 24th ult., is not such an answer to the queries contained in that communication, nor does it furnish such information, as is desired by the board to enable it to form correct opinions upon the subjects confided to it, I am directed respectfully to request that the Honorable Secretary of the Treasury will cause specific answers to be furnished to each of the queries contained in the communication of this board of the 24th ult.; and also to direct that the list of lights, beacons, and buoys, asked for in that communication, embrace a correct description of all the light-houses and light-vessels at present existing, and those now under construction in the United States; specifying the geographical position of each light; the order or class of the light; the number of lamps and reflectors, (if a catoptric light;) the dimensions of the reflectors, burners, frame and lantern; the materials of which the burners and lamps are composed; the names of the keepers and assistants; the date at which they entered upon their duties at the respective light-houses; height of the towers from base to the top of lantern; the height of the light above the level of the sea; date of erection of towers, and lighting of light; when renovated and supplied with new illuminating apparatus; a list of all the dumb beacons belonging to the United States, with a statement of their geographical position, design, description as to material and color; date of erection; and also the position

geographically, and by number and color, of each buoy; its description whether spar, can or nun, buoy—of wood or iron.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,
President Light-House Board.

Hon. THOMAS CORWIN,
Secretary of the Treasury, Washington, D. C.

C—No. 6.

TREASURY DEPARTMENT, FIFTH AUDITOR'S OFFICE,
July 3, 1851.

SIR: I have the honor to enclose herewith, for the use of the light-house board, an answer to all the questions contained in their letter to you of the 24th May, and which were not particularly referred to in my letter of the 7th of June last.

I have the honor to be, sir, respectfully, your obedient servant,
S. PLEASANTON.

W. L. HODGE, Esq.,
Acting Secretary of the Treasury.

C—No. 7.

TREASURY DEPARTMENT,
July 5, 1851.

SIR: Enclosed herewith you will receive the answer of the Fifth Auditor to the queries propounded to him in your letter of the 24th May last, for the use of the light-house board.

Very respectfully, your obedient servant,

WM. L. HODGE,
Acting Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,
President Light-House Board.

C—No. 8.

CLASSIFICATION.

1. There is] no formal classification of the lights, as any such arrangement would be practically useless; for, as there are no two lights built in precisely the same circumstances, and for precisely the same purposes, it is obvious that a perfect classification would embrace as many classes as there are lights.

2. Answer included in the above.

3. Although no formal classifications of the lights are made, yet the heights of the towers and intensities of the lighting apparatus are deter-

mined upon after a consideration of the geographical positions and the requirements of navigation, the distance at which it is necessary to see the light, the extent of horizon to be illuminated, &c. The intensity of the light is regulated by the number and size of the reflectors, which again regulate the size of the lantern, &c.

4. As there is no formal classification of the lights, I cannot give the number classed as first order or class; but in what may be considered first order lights, excepting the lens lights, the diameter of the burners is three-fourths of an inch, the diameter of the reflectors twenty-one inches. The number of reflectors and lamps depends upon the extent of horizon to be illuminated, and the required range or *portee* of the light. For the entire horizon, twenty-four reflectors would be required for a *portee* of twenty miles and over, which allows a divergence of fifteen degrees for each. In the actual state of things, however, this divergence is found to be considerably greater; therefore, for a less *portee* than twenty miles, fewer reflectors than twenty-four are used proportionably. For the various arcs of the horizon, the number is proportional to the angle of the arc.

5. A list of the light-houses will be herewith enclosed.

DISTINGUISHING CHARACTERISTICS.

1. The modes of distinction are—fixed white lights; revolving white lights; fixed red lights; revolving white and red lights alternately; double fixed lights; triple fixed lights (one only;) fixed and revolving white lights (double;) two lights in one tower, one above the other.

2. The answer will be found in the list of lights herewith enclosed.

3. The result of experience has shown that the only modes of distinction for first-class lights are fixed white and revolving white. These are the most efficient and cheapest, and are employed whenever it is possible to do so without risk of confusion. Single, double, and triple fixed lights, two fixed lights in one tower, one above the other, &c., including all those enumerated in the question, are efficient within limited distances, such as for bay, river, and harbor lights, or special localities not requiring much *portee*. They are, of course, more expensive than the fixed or revolving light from a single lantern. With regard to a beam of partly red and partly white light, there is but the one at the Sankaty Head light on Nantucket island; the red beam, or half-beam, has only been added within the last few weeks, and I am not yet in possession of the result. The board will doubtless ascertain it for themselves, by a personal examination. "The means employed to accomplish it" are, halving a Fresnel lens in the line of the focal axis, and giving the upper and lower halves different inclinations, the beam from the lower half being colored by passage through a red medium.

5. *Red* is the only color used. The number will be ascertained from the list herewith enclosed.

6. The colored lights are produced sometimes by colored tubes, sometimes by colored shades. The latter are preferable economically, from the great number of tubes broken; the former arrangement has a slightly less absorption of light, by the absence of the thickness of the transparent tube-glass. As these are, however, very thin and very clear, the difference of light cannot be considered sensible.

7. It is impossible to prevent absorption of light when colored media are used. In these cases, the color is made of as light a tint as possible

and yet be plainly distinguishable. The use of colored lights is, however, highly objectionable, not only on account of the loss of light by absorption, but from the fact that colors cannot be distinguished but at slight distances, and then only in clear states of the atmosphere. Colors are not a reliable mode of distinction, and are only adopted for cases where they are absolutely necessary.

POSITIONS OF LIGHT-HOUSES AND LIGHT-VESSELS.

The questions under this head will be found so fully answered in my communication of June 7th, 1851, to the Secretary of the Treasury, transmitted to the board, that a restatement here is unnecessary. The board is respectfully referred to that communication.

ILLUMINATION, &C., &C.

1. The answer to this question will be fully found in the communication above referred to, to which I respectfully direct the board.

2. There are three lens or Fresnel lights in the United States; two of them at the Highlands of Navesink, New Jersey, and one at Sankaty Head, Island of Nantucket, Massachusetts. Those at Navesink are of the first and second order fixed and revolving. That at Sankaty Head is of the second order revolving. The Navesink lights have one keeper and four assistant keepers. The Sankaty Head light has one keeper and two assistant keepers.

3, 4, and 5. The answers to these questions will be found fully in my communication of June 7, above referred to.

6. The hydraulic or pneumatic lamps have not been introduced, nor am I aware of any objection to their use, further than that I believe the supply of oil furnished to the wick not to be in sufficiently large quantities to insure as intense a light, with safety to the burners, as with the Carcel lamp.

7. Answered in my communication of June 7, above referred to.

8. The first half of this question will be found answered in my communication of June 7. With regard to the last half, if by "*leading marks*" ranging lights are meant, I would state, the only ones are the double lights at Newburyport, Massachusetts, and North Point, Maryland.

9. The answer to this question will be found specifically in my communication of June 7, to which the board are again respectfully directed.

10. There are no reflectors in use of an inferior quality, to my knowledge.

11. The reflectors are formed upon dies made of the perfect form, which dies were first tested as to their truth of form, by mathematicians employed by me for that purpose. In regard to this, the board are referred to my communication of June 7 for further information.

12. The lamps in use for the reflector lights are the fountain Argand lamps, with $\frac{3}{4}$ -inch diameter burner, made of iron, not tipped with silver, which is the means employed to secure durability. An experiment was made with burners tipped with silver, and found not to answer.

13. The answer to this question will be found in my communication of June 7, to which the board is respectfully referred.

14. The reflectors are placed either vertically or slightly differing towards the horizon, depending upon their elevation; the greater the elevation, the greater the dip.

15. Please see my communication of June 7.

16. For answer to the first part of the question, please see my communication of June 7. The length of time for which the reflectors will last and transmit their light without unusual loss by deterioration is so very various, that it is impossible to give a general answer, as all depends upon the care and intelligence of the keepers. They will last from twenty-five to ten years, according to their proper use or abuse. The lamps and reflectors are attached to the chandeliers by rings and solid yokes, made to the proper dimensions for perfect adjustment with screws, &c., and provided with catches or slots to prevent the keeper from losing the adjustment.

17. I know of no such pattern as Alan Stevenson's. Our 21-inch reflectors are made with a large focal distance and great depth; but whether they are precisely similar to Mr. Stevenson's I am unable to say, further than that I know ours, and I believe Mr. Stevenson's, to be true parabolias.

The illuminating apparatus used on our light-vessels is the compass lamp. No Argand burners and lamps are used. It is simply a reservoir to hold the oil, with a number of wicks placed around the circumference, the whole swung in gimbals and hoisted up and down (when placed in the lantern) a pair of shears in the vessel, with counter weights.

18. The expense of repairs for the lamps alone has not been kept separate.

19. For the lights on the Atlantic coast, the average consumption of oil per lamp is thirty-five gallons per annum; the lamp is kept burning from sunset to sunrise. For further information please see my communication of June 7th.

SUPPLIES, &c.

1. This question is fully answered in my communication of June 7th, to which the board are respectfully referred.

2. The painting, whitewashing, repairs, &c., are done annually under instruction from this office, by contract to the lowest bidder, the local superintendent of lights, or some qualified person employed by him or myself, making previously the necessary examinations and specifications, estimates, &c.

3. Bells are employed in foggy weather.

4. Such as can be rendered by the keeper, and in his judgment are prudent to attempt.

5. The oil, &c., is kept sometimes in the towers, and on the northern coasts more generally in the cellars of the houses. The towers have no special oil cellars, the cellars of the dwelling-houses being large, and used for that purpose when the climate makes it necessary.

The oil is kept at a sufficiently equable temperature, either in cellars or in the towers, by stoves in the lanterns, when made necessary by great variations of weather. The tanks in which the oil is kept are tinned iron, painted thoroughly. This is considered the most economical method of keeping the oil, and losses from leaks rarely occur. When they do occur, it is generally from carelessness in the keepers.

LANTERNS, GLAZING, &c.

1. The lanterns are constructed of wrought-iron angle posts, sashes, &c., with copper domes.

2. The difference of first cost between iron and bronze lanterns would probably be, taking the iron ones at 1, 2.25.

3. There is no advantage in the use of bronze for lanterns; it may be urged they are more durable from their not corroding; but when it is considered that the lower ends of the iron posts are leaded or brimstoned into the capping, and all the rest of the surface kept well painted, it will be perceived that there can be no greater durability. This involves the question of repair likewise: if there be no corrosion, there will be no repairs required, and the cost of painting is too trifling to enter as an element in the comparison "finally." With regard to lightness, the advantage is on the side of wrought-iron, which in similar and equal pieces is *stiffer* than bronze; consequently, to bear a cross strain, which is the only one the lantern posts suffer, *greater* thickness is required with bronze, by which more light is shut out.

4. French plate-glass is used of all sizes, from 16 by 28 inches up to 5 feet by 2½ feet, according to size of lantern, description of lighting apparatus, &c. Many of the *very* old lanterns are glazed with common glass. These, as fast as my means permit, are being removed, and improved lanterns substituted.

5. The size of the sashes or astragals varies with dimension of lantern. The angle posts range from one and a half to one inch broad, generally, with the exception of the *very* old lanterns, when they are sometimes two inches. The sashes average from one-half to three-quarters of an inch broad.

6. The astragals are all horizontal. The small glass is put in by putty, the large by pins; the very largest by sash-bars and top-screws. The lanterns are kept painted on the interior, sometimes black and generally white. They are painted under the direction of the local superintendent, whenever he considers they need it. Spare glass, &c., kept on hand to repair broken panes. The system of ventilation in general use is by a top ventilator, traversing, of various forms, or Collins's patent, and by side-ventilators, in the base of the lanterns, or in the lantern doors; but these means are very inferior to what is furnished by the scuttle door being left open, which, using the whole height of the tower for chimney, gives a powerful draught, of such efficiency as cannot be obtained by any other arrangement; and this is resorted to even where the lantern bases are well supplied with small ventilators.

Professor Faraday's ventilating tubes are not used, as the open scuttle supplies a power of draught and a quantity of air sufficient for perfect combustion, without them.

ATTENDANCE UPON THE LIGHTS, &C., TO SECURE EFFICIENCY, CERTAINTY AND CLEARNESS.

The keepers are appointed by the Secretary of the Treasury—one to each light, with the exception of the Navesink and Sankaty Head lights, at the north, and those lights at the south specified in the manuscript catalogue. The Navesink light has one keeper and four assistants; the Sankaty Head light, one keeper and two assistants; these being lens lights. The assistants are appointed by the keepers, with the sanction of the local superintendent. The southern lights having assistants, have but one assistant each. The keepers are not instructed previously to entering upon their duties, the trimming and cleaning of a small Argand fountain lamp being so simple and self-evident as to be left to the intelligence of the meanest

capacity. Keepers are supplied with printed instructions, to guide them in the performance of their duties, copies of which instructions I have sent the board.

The towers are painted or whitewashed, by order of the same persons and in the same manner as the repairs are attended to. The general distinguishing mark of the towers, by day, is their colors. They are either whitewashed, which is the general case, or have a red stripe horizontally between two white ones, as at Sankaty Head light; or they are partly dark brown and partly light, one color above the other, as at Cape Hatteras light; or by the dark granite color of the stone, as at Saddle-back Ledge, Monhegan lights, and others. Others are distinguished by the number of the towers, as two, or three. The number of these will be obtained from the accompanying catalogue. Alarm signals are made in foggy weather, by bells rung by machinery. The number of localities fitted with bells will be found in the accompanying catalogue.

CONSTRUCTION.

1. There is not what may be called any general system of construction, though there are generally adopted four sizes of towers; each locality has had a particular plan and specification made for it.

2. To give the modes or plans employed, would involve sending copies of the contracts, specifications, and working-drawings of over three hundred light-houses; a labor which it is entirely out of my power to perform with the means of my office. Most of the specifications and working-drawings were used up by the workmen; and as they were merely ordinary arrangements of work suited to special cases, they had no further value, and were not preserved. To give copies of these trivialities would be impossible, and useless if possible.

3. The kind of tower, if for difficult locations, is sometimes made at this office, sometimes by experienced engineers employed by me for that purpose, and in all cases examined and approved by me.

4. All work done for this office is done by contract by the lowest bidder at a public letting. The contracts embrace the entire work generally, excepting in particular cases, where the lighting apparatus is furnished by a separate contract; where it is not, the contractor for the whole work is bound to obtain the lighting apparatus from the manufacturer designated, at a certain price, according to a previous contract with this office. This is to insure the proper kind of lamps and reflectors. I know of no objection to this system, and its advantage over the "day-labor" system is found in its greater economy. A regular superintendent is employed to oversee the direction of the work day by day, inspect materials, &c. He is either an experienced mechanic or engineer, as the case may require, and no money is paid without his certificate that the work is faithfully executed according to contract.

5. Conductors are attached to light-houses, by the ordinary means familiar to all.

6. As many different means are employed to restore impaired foundations, as there are foundations so impaired, varying with the circumstances and the resources of the mechanics and engineers employed for the purpose.

The board will perceive the absurdity of requiring general answers to cases which vary with every variation of locality, and that, too, upon mere

points of constructive detail, involving nothing greater than the particular plan of shoring up a house, or underpinning a tower, in which all that is required is a small knowledge of ordinary mechanical means, such as is in the possession of every master-workman or engineer. The only general answer I can give is, that each problem has its particular solution. These repairs are contracted for and superintended in the same manner as the construction; their necessity is ascertained by surveys, made by the local superintendents.

LIGHT-VESSELS, BUOYS AND SEA-MARKS.

1. The light-vessels are procured by contract from the lowest bidder. Their models vary for the different positions they occupy. The internal arrangements, &c., will be found from the two enclosed specifications, one of a small-class, the other of a large-class vessel. A light-vessel will last, according to latitude and timber, from five to ten years. The average annual repairs are very great, and are so included in the cost of maintenance as to be difficult of separation. The greatest number of men employed on them is, for the most exposed stations, ten; for the least exposed, four men; and for other stations in proportion. The pay of the crew is regulated by the pay of sailors from the nearest port. In addition to their pay, each man is allowed one ration per day. The pay of the captain on sea-stations is \$700 per annum; on bay and sound-stations, \$500 per annum. For further information and more detailed, please refer to the manuscript book I have already sent the board.

2. The light-vessels are not removed unless they need repairs. There is only one relief-vessel, which is kept at Norfolk, Va. They are kept the entire year at their moorings, excepting the one at Stratford point, Long Island sound, and the two in the Potomac river. These are removed in December and replaced in March.

3. The light-vessels are moored by pilots; the plan of mooring will be seen from the enclosed specifications.

4. The light-vessel moorings are examined by the captain from time to time, and are renewed when judged necessary, after examination by the local superintendent on report of the captain, or by some competent person employed by him for that purpose.

5. There is no system of relief for captains or crews.

6. The captains are required to live on board, and they cannot delegate their authority to others.

7. The captains of light-vessels are not required to have belonged to any particular profession; generally, captains from the merchant service are employed. The same system for inspection and repair provides for light-vessels as for light-houses. When repairs are needed, and reports made, their communications are sent by the captains to the local superintendents.

8. The printed instructions to masters of light-vessels have already been furnished.

9. The same means are employed to ascertain the proper positions of buoys, beacons, and sea-marks, as for ascertaining the proper positions of light-houses, as already detailed.

10. The buoys are placed by contract with pilots; they are taken up and replaced in the same manner, by orders from this office.

11. The buoys are distinguished according to the act of Congress, approved September 28, 1850, to which I respectfully refer the board.

12. When buoys have been carried away, the fact is ascertained by report of masters of vessels and pilots. They are immediately replaced by the local superintendent.

13. No buoy can be placed, except by act of Congress. There are, then, no casualty buoys. A catalogue of the different buoys will accompany this communication. The contractor is constantly going round to ascertain if the buoys be in their proper positions.

14. Answered in the preceding.

15. They are only raised where immediate danger is apprehended from ice, freshets, &c., and then by the contractor. They are replaced the moment the danger is past.

16. The expenditure with the buoyage is regulated in the same manner as for the light-houses.

17. There are but two tenders—one in Delaware bay, hired; and one at New York, belonging to the light-house establishment. The expense of the New York tender for the year 1849 was \$3,250 28. The Delaware tender is hired by contract from the lowest bidder; the present price is \$995 per annum.

MISCELLANEOUS.

1. Notices are given to mariners by advertisements in the public papers of extensive commercial circulation. The notices are from one to two months previous to the lighting or changing of any light, &c.

2. There are but two inspectors employed in addition to the local superintendents, one upon the northern lakes and one at New York.

3. None other than the keepers are employed permanently in connexion with the gas-lights. The number of gas-lights, and such other information as I have to communicate, will be found in my communication to the board of the 7th June, 1851.

4. For the number of light-house districts, &c., please see the manuscript book already referred to, as sent by me to the board.

5. Two and a half per cent. is the commission allowed upon the expenditures.

6. The manner in which inspections of lights are made by the local superintendents, &c., has already been given in the preceding; the results are reported to this office for approval, necessary instructions, &c.

7. All the information relative to the employment of gas, &c., in the possession of this office, has already been given in the various communications made to the board, nor am I aware of being in the possession of anything more to add.

C—No. 9.

TREASURY DEPARTMENT,
Fifth Auditor's Office, July 7, 1851.

SIR: In making up the answer to the questions propounded by the light-house board, it was omitted to notice that in respect to obtaining the

supplies of oil annually. I now supply that omission by sending a copy of the printed advertisement for the year, of the several bids received in pursuance of it, and of the contracts entered into with the party. The same course is taken twice in each year—once with respect to the northern lights, early in the year, and once in respect to the southern lights the latter part of the year.

I have the honor to be, sir, very respectfully, your obedient servant,
S. PLEASANTON.

To WM. L. HODGE, Esq.,
Acting Secretary of the Treasury.

C—No. 10.

TREASURY DEPARTMENT, *July 8, 1851.*

SIR: I enclose herewith a letter from the Fifth Auditor, of the 7th instant, with sundry papers, intended to show the manner of supplying the light-houses with oil.

Very respectfully, your obedient servant,

WM. L. HODGE,
Acting Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,
President Light-house Board, now at Boston.

C—No. 11.

CUSTOM-HOUSE, BOSTON,
Collector's Office, March 24, 1851.

SIR: The proposals for furnishing oil for the light-houses for the ensuing year were opened this day; and the following is a list of the respective bids, viz:

For the Atlantic coast.

Samuel Learnard & Co.-----	\$1 18 $\frac{1}{2}$
E. M. Robinson-----	1 22 $\frac{1}{2}$
O. & G. Crocker-----	1 25

For the lakes.

Samuel Learnard & Co.-----	1 25
Lawrence Grinnell-----	1 27 $\frac{1}{4}$
Kingman, Rice & Henry-----	1 35
Z. Southard & Co., for Buffalo-----	1 29
Do. do. Oswego-----	1 28
Do. do. Plattsburgh-----	1 27

You will observe that Messrs. Samuel Learnard & Co. are the lowest

bidders for both the coast and the lakes, and I shall accordingly enter into contract with them.

The supply schooner, *Eliza*, has returned from the southern coast, and will take on board the first cargo for the middle division of the eastern coast; and I shall charter the other vessel, as last year, for the four months only, for the delivery of supplies on the coast of Maine and Massachusetts.

I am, sir, your obedient servant,

P. GREELY, Jr.,
Superintendent.

S. PLEASANTON, Esq.,
Fifth Auditor, &c., Washington, D. C.

C—No. 12.

Extract of a letter to the superintendent of lights at Boston, from Benjamin T. Congdon, inspector of oil, dated New Bedford, Massachusetts, December 16, 1845.

“The oil sent from Boston to the lakes was furnished by E. Milliken & Co., and was the first lot which I examined the present year. I tried the burning of each barrel, and the oil was entirely consumed in each lamp, with the exception of three or four out of nearly a hundred used, and in these three or four but very little remained. This was the case with both winter and spring oil.

“For the winter oil I adopted the test of the late Mr. Harris, formerly the inspector for the government; that is, 32° of the thermometer. I tried the oil in the mixture of ice, salt, and water, and not a cask was sent that did not remain limpid at 32°, and the greater part at 30°. I also tried it on ice, and it remained limpid thereon for the space of fifteen minutes. The manner of testing winter oil was used by Mr. Harris, and, I believe, the only test which he used.

“The spring oil I tested at a temperature of 45°. I had previously ascertained that oil strained in the month of April would remain limpid at this temperature.

“BENJN. T. CONGDON.”

The above is a true extract of a letter as above stated.

J. D. KING, Clerk.

TREASURY DEPARTMENT,
Fifth Auditor's Office, June 7, 1851.

C—No. 13.

Copy of advertisement for oil supplies in 1850.

CUSTOM-HOUSE, BOSTON, March 1, 1850.

Sealed proposals will be received at this office, until Monday the 25th instant, at twelve o'clock m., for supplying sixty-six thousand gallons of the best quality of sperm oil; one-third part winter pressed from head matter, and two-thirds part spring oil; to be delivered at New Bedford, in

casks suitable for shipping, in prime order; one-half of the above named quantity to be delivered on or about the 10th day of April next, and the other half on or about the first of July next. Separate proposals, sealed, will be received at this office, until the said 25th inst., at twelve o'clock m., for furnishing for the use of the United States, to be delivered to the collector of the customs at Buffalo, New York, five thousand two hundred and ninety gallons of winter-pressed oil from head matter, and four thousand three hundred and ninety gallons of spring oil, on or about the first day of May next; also to be delivered to the collector at Oswego, New York, three thousand five hundred and forty gallons, one-third winter and two-thirds spring oil, of equal purity, on or about the same time; also to be delivered to the collector at Plattsburgh, New York, nine hundred and sixty gallons of equal purity, and in like proportion, about the same time. All of said lots of oil to be delivered at said places, in small iron-bound casks, in prime order, from fifty to sixty gallons each, and free from any expense to the United States, and at the risk of the contractor, and all of the several lots to be subject to inspection and test prior to acceptance, and no winter oil will be received which will not stand limpid at 30° of Fahrenheit, and the spring oil at 45°. The oil to be transported to Buffalo, Oswego, and Plattsburgh, to be inspected and tested prior to transportation, and the other lots when the vessels employed for the delivery of the supplies are ready to receive the same on board, and all to the satisfaction and approval of the superintendent.

P. GREELY, Jr., *Superintendent.*

C—No. 14.

Copy of contract for supplying oil in 1850, per advertisement.

Agreement entered into this twenty-fifth day of March, in the year of our Lord one thousand eight hundred and fifty, between Edward Mott Robinson, on the one part, and the United States of America on the other part, witnesseth:

That the said Edward Mott Robinson, on his part, agrees and engages to furnish for the United States sixty-six thousand gallons of the best quality sperm oil, one-third part winter-pressed, from head matter, and two-thirds part spring oil, to be delivered in New Bedford, in casks suitable for shipping, in prime order; one-half of the above named quantity to be delivered on or about the tenth day of April next, and the other half on or about the first day of July next. The oil to be subject to inspection and test prior to its acceptance, by Philip Greely, junior, superintendent of light-houses in Massachusetts, on behalf of the United States, or by such person as he may appoint for that purpose; and no winter oil will be accepted which will not stand limpid at thirty degrees of Fahrenheit, and no spring oil which will not stand limpid at forty-five degrees. And the said Philip Greely, junior, in his official capacity, acting on behalf of the United States, engages and agrees to pay, or cause to be paid, to the said Edward Mott Robinson, at the rate of *one hundred and eleven cents per gallon*, when the same shall have been gauged, tested, and inspected, and delivered on board of the supply-vessels to the acceptance and satisfaction of the said Philip Greely, jr.

In witness whereof, the parties hereunto interchangeably set their hands and seals the day and year before written.

P. GREELY, JR. [L. S.]
EDWD. MOTT ROBINSON. [L. S.]

Signed, sealed and delivered in the presence of—

W. A. WELLMAN,
JONATHAN HOWLAND.

C—No. 15.

Copy of contracts for supply of oil for United States lights on the lakes in 1850.

Agreement entered into this fifth day of March, in the year of our Lord one thousand eight hundred and fifty, between Lawrence Grinnell, merchant, of New Bedford, in the State of Massachusetts, on the one part, and the United States of America, on the other part, witnesseth :

That the said Lawrence Grinnell, on his part, agrees and engages to furnish, for the use of the United States, to be delivered to the collector of customs at Buffalo, New York, five thousand two hundred and ninety gallons of the best quality of winter pressed oil, from head matter, and four thousand three hundred and ninety gallons of spring oil of equal purity, on or about the first day of May next; also to be delivered to the collector at Oswego, New York, three thousand five hundred and forty gallons of oil, one-third part winter, and two-thirds spring oil, of equal purity, on or about said first day of May next; also to be delivered to the collector at Plattsburg, New York, nine hundred and sixty gallons of like quality of oil, apportioned as aforesaid, on or about said first of May next; all of said lots of oil to be delivered at said places, in small iron-bound casks, in prime order, containing from thirty to fifty gallons each, and at the expense and risk of said Lawrence Grinnell; and all the oil to be subject to inspection and test prior to its acceptance, by Philip Greely, junior, superintendent of light-houses in Massachusetts, on behalf of the United States, or by such person or persons as he shall appoint for that purpose, and no winter oil will be received which will not stand limpid at thirty degrees of Fahrenheit, and the spring at forty-five degrees. And the said Philip Greely, junior, in his official capacity, engages to pay, or cause to be paid to the said Lawrence Grinnell, at the rate of one hundred and sixteen and one-third cents per gallon, when the same shall have been gauged, tested and inspected, to the satisfaction and acceptance of said Philip Greely, junior, and evidence is produced of the delivery thereof, as aforesaid.

In witness whereof, the parties hereunto interchangeably set their hands and seals, the day and year before written.

P. GREELY, JR. [L. S.]
LAWRENCE GRINNELL. [L. S.]

Signed, sealed and delivered in presence of—

W. A. WELLMAN,
JONATHAN HOWLAND.

C—No. 16.

Copy of contract for the supply of lamps, reflectors, &c.

Agreement entered into this thirtieth day of July, in the year of our Lord one thousand eight hundred and fifty, between Benjamin Hemanway, of Boston, in the State of Massachusetts, copper-smith, on the one part, and the United States of America, on the other part, witnesseth:

That the said Benjamin Hemanway, on his part, agrees and engages to furnish the United States lamps, reflectors, and every other article which may be required to fit up any light-house, or refit any old one, as specified in said Hemanway's proposals for supplying light-house apparatus, a true copy of which is hereto annexed.

And the said Hemanway agrees and engages that every article furnished shall be made in the best manner, to be determined and approved by the superintendent of lights at Boston, or such person as he shall designate for that purpose, and that the reflectors shall be made in moulds or dies of a true parabola shape; that they shall contain the quantity of pure silver specified, of which a certificate shall be produced from the manufacturer.

And the United States, by Philip Greely, junior, in his official capacity only, acting under instructions from the Fifth Auditor of the Treasury, dated July 22, 1850, agrees to pay to said Benjamin Hemanway the prices named for each article delivered according to this agreement, as per tariff or rates set against each article in the copy of proposals hereunto annexed; it being agreed and understood that this contract shall continue for the period of one year from the date hereof. And to the true and faithful performance of all and singular the agreements as aforesaid, the said Hemanway binds and obliges himself, and his heirs or assigns, in the penal sum of five thousand dollars, firmly by these presents.

In witness whereof, the parties aforesaid do interchangeably execute this instrument, the day and year before written.

BENJAMIN HEMANWAY. [L. S.]
P. GREELY, Jr. [L. S.]

Signed, sealed and delivered in presence of—
W. A. WELLMAN.

A true copy of the original on file in this office.

WM. A. WELLMAN,
Assistant Collector.

CUSTOM-HOUSE, BOSTON,
August 8, 1850.

C—No. 17.

Memorandum of offer for supplying light-house apparatus, by Benjamin Hemanway.

Reflectors, 21-inch, 15-oz. silver, each.....	\$60 00
Do.....16-inch, 7-oz.....do.....	27 25
Do.....15-inch, 5-oz.....do.....	23 50
Do.....14-inch, 4½-oz.....do.....	21 00
Clock machine, large size.....	275 00
Do.....small size.....	187 00
Chandeliers, 2 feet 8 inches in diameter.....	27 00
Do.....under 2 feet 8 inches in diameter.....	22 00
Do.....large, revolving, for 14 large reflectors.....	42 00
Do.....small, revolving, for 10 reflectors.....	32 00
Brass lamps, complete.....	5 50
Brass box, 21-inch reflectors.....	3 00
Do. . . 16...do.....	2 50
Fitting reflectors on chandeliers.....	75
Heaters for lamps.....	50
Spare tubes for lamps.....	16
Painting chandelier, packing lamps, &c.....	4 00
Wick formers, each.....	6
Snuffers.....	50
Tripoli powders, per dozen.....	75
Glaziers' diamonds, each.....	4 00
Glass lanterns for keepers.....	1 00
Buff-skins, per dozen, fine quality.....	8 00
Seepors.....	4 50
Plyers.....	4 50
Oil butts, double tin, 90 gallons.....	10 00
Do.....do..... 15...do.....	4 00
Tube boxes, each.....	1 75
Wick boxes, each.....	1 75
Measures, 3-gallon.....	1 75
Do.....2...do.....	1 50
Do.....1...do.....	87
Trimmers, burners, for repairs, each.....	2 50
Brass.....do.....do.....do.....	2 75
Brass shacks to put up chandeliers.....	2 50

C—No. 18.

Letter from P. Greely, Jr., Esq., collector of customs and superintendent of lights, &c.

CUSTOM-HOUSE, BOSTON,
October 9, 1851.

SIR : In compliance with your letter of the 10th ultimo, I have the honor to furnish such information in relation to the mode by which supplies are procured, of oil, tube-glasses, buff-skins, lamps, burners, reflectors, &c., and the repairing of the illuminating apparatus, in answer to the queries propounded, to wit :

Q. How and by whom are purchases of supplies made for light-house purposes—by open purchase in the market, by tenders, circular proposals, public advertisement in the newspapers? and for how long a period of time before the proposals are acted on, or by what other mode or means?

A. By instructions from the Fifth Auditor of the Treasury, contracts are made upon tenders received, after public advertisement in the newspapers, ordinarily for two weeks, the proposals being first sent to the department for approval.

Q. Under whose instructions are purchases made; are they printed or written, or verbal; general or specific, as to quality, quantity, size, description, &c., &c.?

A. Written and specific, from the Fifth Auditor.

Q. How and by whom are supplies of all articles for light-house purposes selected, tested as to quality or suitableness, accepted and received?

A. Tested by the superintendents, or by competent persons.

Q. To what tests are the oils for the light-houses and light-vessels subjected, (please state in detail) and by whom are these tests applied—by dealers in the article, public officers, or scientific or other persons?

A. By the oleometer, and by burning a sample from each cask presented for delivery by the contractors, under the personal supervision of a scientific gauger.

Q. What the position under government of the person selected to test oil, &c., for the light-house establishment, and what additional compensation does he receive for this particular service?

A. None; the person selected to test and gauge the oils is specially employed for that purpose and no other, and receives compensation for that particular duty.

Q. By whom are the various articles of supplies selected before purchase is made of them, by whom received, where kept, and by whom distributed?

A. No articles are received from the contractors until the supply-vessels are ready to take them on board, from which vessel they are distributed.

Q. In whose charge, and where is the oil, &c., placed after it has been tested and accepted, before it is sent on board the distributing vessel; is it placed in a public building, in a private building or place, and what security is there to prevent injury to it by design or accident?

A. It is placed on board of the vessel employed by the government as soon as tested, and duly receipted for, before payment is made.

Q. Are the articles annually required for the light-house establishment, described minutely in the instructions ordering them to be procured?

A. The size, quality, &c., are described in the contracts, and required in agreement thereto.

Q. Who examines, inspects and decides upon the kind and quality of polishing-powder for reflectors, brass-work, plate-glass of lantern, &c., &c., and upon whose decision are these articles accepted?

A. The polishing powder is the patented *tripoli*. Reflectors, plate-glass, &c., for the lanterns are procured under contract, and the superintendent decides upon the same.

Q. What rule, if any, obtains with reference to the quantity and quality of the different articles required in this department of the public service, and what in distributing them to the different light-keepers, as to the quality and quantity of each article?

A. Oil is distributed equal to thirty-five gallons per lamp; one-third winter and two-thirds spring.

Q. Where and by whom are proposals or tenders issued and contracts entered into, for the purchase of annual supplies of oil and other articles necessary for the light-house establishment?

A. At this office for such as the department may from time to time direct, in the manner described, in answer to the first interrogation.

Q. Who decides upon the size, description, and quality of the lamps, burners, and reflectors for the different lights requiring these articles for renovation or improvement of a certain light?

A. The articles for renovation are of uniform size, &c., and ordered by the superintendent; those for improvements are furnished only by instructions from the department.

Q. Who superintends the construction of the reflectors, lamps, burners, frames, &c., annually required for renewing or improving the lights?

A. The superintendent, or competent persons appointed by the superintendent for that purpose.

Q. Who tests the reflectors, before being received, as to shape, size, and quality? Are they subjected to examination and test by a scientific or other person?

A. The reflectors are formed in a die. They are duly examined and the certificates required under the contracts obtained prior to acceptance.

Q. Are reflectors and lamps ever received from the manufacturer without being subjected to a careful examination as to shape and quality of material?

A. Answered just above.

Q. By what means is the quantity of the different articles ascertained, and to whom are the surplus supplies returned at the end of the voyage of the distributing vessel or vessels?

A. The quantity of each article required is ascertained and a receipt therefor procured of Captain John Howland, who is employed to distribute the same, and who duly accounts for each and every article delivered, by receipts from each keeper, and who likewise accounts for any surplus at the end of the voyages.

Q. Who receipts to you for the articles purchased by you for this service, and how is the receipt of the master of the distributing-vessel cancelled?

A. The masters of the distributing-vessels receipt for the articles laden on board their respective vessels, as received from the contractors, and the same are cancelled by the return of the several receipts, in detail, of the keepers of the lights.

Q. What means are employed to insure the faithful delivery of the articles intended for distribution to the different light-keepers?

A. A contract, with a penal consideration: the person employed having been in this service for fifteen years or more.

Q. What is the proportion of summer and winter oil contracted for and distributed?

A. Equivalent to 35 gallons per lamp: one-third winter, two-thirds spring oil.

Q. In making contracts for reflectors, do the proposals and contracts specify the proportion of silver to copper, per pound of copper, by the size or otherwise, or are they contracted for with reference to size alone, and without reference to their precise shape?

A. The contracts specify the size and shape, and the quantity of silver in each, viz: 21-inch reflector, 15 oz. silver; 16-inch, 7 oz.; 15-inch, 5 oz.; 14-inch, 4½ oz.

Q. By whom and under whose special inspection and superintendence are the lamps and reflectors placed in the frames in the lanterns—a contractor, a scientific or other professional person?

A. By the contractor, under the superintendent or a competent person.

Q. Who receives old lamps, reflectors, oil tanks, &c., &c., and what disposition is made of them, and under whose direction?

A. The superintendent, under whose direction the same are sold and the proceeds duly credited to the United States.

Q. Who assists you in discharging the duties of superintendent of lights and making the purchases of annual supplies, &c., &c., and how much is paid annually to this assistant for this special service in addition to his regular salary in the custom-house?

A. Mr. William A. Wellman, who is paid for that special service \$500 per annum as inspector of lights, but he has no authority to make purchases, everything being procured under contract made with the superintendent.

Q. How many years has it been since the purchase of annual supplies has been made by or under the direction of the collector of the customs at Boston?

A. It appears by the records at this office that, on the 5th of June, 1839, one of my predecessors was directed to procure supplies for a portion of the lights on the Atlantic coast, the contractors having abandoned the contract with the United States. The lights in the Rhode Island and New York districts were supplied under separate contracts made with the local superintendents of those districts, for some years subsequently. During the past three years, the contracts made here have included the whole coast.

Q. Who directs and how are repairs made to the illuminating apparatus of the different lights, and how are the expenses for these repairs estimated, and by whom?

A. The repairs are directed by the Fifth Auditor, upon reports from the superintendents, with the necessary estimates of cost.

Q. How and by whom are the supplies distributed, how often during the year, and what the annual expense for this service?

A. Supplies are distributed by Captain Jonathan Howland, and Captain Joseph Howland, annually; the former in the schooner *Eliza*, chartered at the rate of \$700 per month, including his own compensation, and the latter for four months in the year, in the schooner *Augusta*, at the rate of \$610 per month, including himself, mate, crew, &c.

Q. Are the patterns furnished for making tube-glasses, scissors, &c.?

A. Patterns are furnished except for scissors.

Q. Is there a detailed list of necessary articles to be supplied to each light-house, or does the person charged with the delivery of supplies ask for and receive such articles only as he may think proper?

A. The persons charged with the delivery receive specific instructions in regard to the supplies, and make detailed reports of quantities delivered at each place, with the requisite receipts for the same.

Q. What disposition is made of oil and other articles returned by keepers as unfit for use?

A. Sold at public auction and the proceeds credited to the United States.

Q. Are the wicks made of the same texture or quality, and the tube-glasses of the same or different shapes?

A. The tube-glasses are made by the New England Glass Company, and the wicks manufactured at Providence, Rhode Island, and warranted of uniform texture and quality.

Having answered as fully and explicitly as I am able, from the facts within my reach and of my knowledge of the details of business, the various questions as above, I am not aware that anything remains of sufficient importance to add to my communication. The service has grown up under the management of the present Fifth Auditor of the Treasury, and I deem it but an act of justice to bear testimony to the faithful and diligent manner in which he has discharged its arduous and responsible duties. Since I have been in office, I have ever found him most prompt in his correspondence; his instructions have always been clear and explicit, and the vast expenditures authorized by Congress have been disbursed under his directions with great accuracy, so far as I am able to judge. I think, also, that in the main, the system now pursued gives good satisfaction to everybody.

I am, sir, very respectfully,

P. GREELY, JR.,
Collector and Superintendent.

THORNTON A. JENKINS, U. S. N.,
Secretary to Light-house Board, Washington, D. C.

C--19.

Letter from Jonathan Howland, Esq., commanding vessel for distributing supplies to light-houses.

NEW BEDFORD, September 25, 1851.

GENTLEMEN: The following are the answers to your questions relative to the light-houses, &c., as far as I am able to answer them:

Q. How long have you been charged with the duty of delivering supplies to the light-houses and light-vessels of the United States?

A. I commenced under contract in 1828, and in 1839 was first employed by the government.

Q. Under whose orders or directions did you act when first employed on this duty?

A. Under the direction of C. Grinnel, jr., & Co., when under contract, and then by direction of the collector of Boston.

Q. How were supplies furnished when you were first employed—by contract per specific article required, or by contract per lamp per annum?

A. By contract per lamp, to furnish specified articles as much of each as was necessary, and to keep the apparatus in repair.

Q. How long did that system last, and when did it change?

A. The system was changed in 1839; had continued probably 18 or 20 years: first contract by W. Lewis; second by C. Grinnell, jr., 5 years; third by C. W. Morgan & Co., for 6 years.

Q. Has the present system been continued without modification since the contract per lamp was abandoned?

A. There has been no material change.

Q. How are supplies obtained now?

A. By advertising for proposals to furnish the articles required.

Q. When did the present mode of obtaining supplies commence?

A. When the contract per lamp was given up, in 1839.

Q. From whom do you receive supplies for the lights, and what steps do you take to obtain them?

A. From the collector of Boston. He notifies me that such a quantity of oil has been purchased for the light-houses, and directs me to take it on board and deliver it in such quantities as each light-house may require.

Q. Who determines the quality and quantity of supplies which are sent to you?

A. Determined by the light-house department.

Q. What agency have you in purchasing supplies? Do you make any purchases yourself?

A. Not any. I am requested at times to purchase cloth and soap, and some other small articles.

Q. Have you any means of ascertaining the quality of articles furnished to you for distribution?

A. I have none for oil, or, in fact, for any other article.

Q. How do you ascertain the quantity of the articles sent to you?

A. By counting.

Q. Do you not receipt for all articles sent to you for distribution?

A. I do.

Q. What becomes of any surplus articles at the end of the cruise for distributing supplies?

A. If we have a surplus from our cruise it is usually used for the next, and so on.

Q. By whose orders are new lamps, burners, reflectors, diamonds, scissors, lamp-feeders, oil-tanks, &c., supplied to keepers?

A. In furnishing a lantern complete with a new chandelier, new lamps, and reflectors, I have nothing to do with it; but when any of them get out of order, government has left it with me to make such repairs as I may deem necessary; and so in relation to other articles, such as oil-butts, canisters, lamp-feeders, &c.

Q. What means are employed to ascertain the condition of the articles in use before furnishing new ones? Who condemns the old ones?

A. My experience teaches me when an article is worn out, and in such cases I condemn them.

Q. Who determines the extent of repairs required to lamps, burners, &c.?

A. I generally do it.

Q. Do you make any other repairs than those in the immediate line of the tinker employed to solder lamps, &c.?

A. Not very often.

Q. Do you repair leaks in the lantern, replace broken glass, &c.?

A. I do not.

Q. Are the supplies ever complained of by the keepers?

A. They are not very frequent; and when they are made, they are not always well founded.

Q. Are they not compelled to receive and receipt to you for whatever you may think proper to furnish them with?

A. They are not compelled, but they generally receipt willingly for everything I deliver.

Q. Are not complaints frequently made of the quality of the oil, polishing powder, trimming-scissors, &c.?

A. Complaints are made, sometimes without justification.

Q. Are not the reflectors greatly injured in a short time after being put

up, by the use of bad tripoli, or other bad polishing-powder furnished by the contractor to you?

A. I think in some cases they are, but it is trifling compared to the injury they receive from inattention or carelessness of the keepers.

Q. How often do you visit each light in a year?

A. But once.

Q. How long do you remain, on an average, at each light?

A. From two to twelve hours; probably the average would be three hours.

Q. How are you paid, and by whom, for repairs of lamps, burners, &c.?

A. I have nothing to do with furnishing such things; or rather I ought to have said, and I now do say, that I do not have any pay for such repairs. I am paid so much per month for furnishing vessels and everything requisite for the business.

Q. How many gallons of oil can you take on board the vessel you use for distributing the oil and other supplies?

A. From 18,000 to 20,000 gallons.

Q. How many tons measurement?

A. One hundred and forty.

Q. How long between perpendiculars?

A. Eighty feet.

Q. What breadth of beam?

A. Twenty feet.

Q. What depth of hold?

A. Eight feet four inches.

Q. How many men do you carry on board?

A. Ten men, all told.

Q. How many vessels are employed to deliver supplies per annum. What number of months are both vessels employed in that duty?

A. One vessel by the year—one from four to five months.

Q. How much per annum do you and your brother, and all others interested in the vessels employed to distribute supplies, receive for the services rendered, including repairs of lamps, &c., &c., and including all extra allowances?

A. Seven hundred and sixty-five dollars per month for the one that is employed all the year, and six hundred and seventy-five dollars for the other, which is all that I get from the government for every thing that I do, or my brother does, or any body else does.

Q. What are the limits of your cruising ground, with supplies?

A. Our limits include all the light-houses on the coast, bays, lake Pontchartrain, sounds, rivers, inlets, creeks, and harbors from Vermillion bay to West Passamaquoddy Head.

Q. Do you make any report of the condition of towers, buildings, apparatus, &c., when you visit them with supplies?

A. I make a report of all such to the collector of Boston.

Q. Have you ever had any written or printed instructions as to the manner of performing the duties confided to you, connected with the lights?

A. I have not.

Q. What rule is followed in regard to the quantities and qualities of oil to be left, per lamp?

A. The rule followed is to deliver to each light-house as much oil as it consumes annually.

Q. Do you make any difference between the lights north or south of the Chesapeake, or north and south of any point on the coast?

A. Not any.

Q. Do you ever compare the lights one with another during your voyages?

A. Not by any standard; we say, for instance, Boston light is a very good one; Nantucket point, West Chops, they are also very good compared to others, but compared to Sankaty head, they are poor or inferior.

Q. Do you ever report, and to whom, that certain lights are bad, certain other lights are good, &c., &c.?

A. Such are included in our general reports.

Q. Have you not had good opportunities for making a fair comparison of the different lights on the coast of the United States?

A. We have, but have never classified them.

Q. How do the lights on the seacoast generally compare with the lights at Navesink and Sankaty Head; such, for example, as Dry Tortugas, the two passes of the Mississippi, Cape Fear, Cape Lookout, Cape Hatteras, Cape Henry, Cape Charles, Assateague, Cape Henlopen, Cape May, Fire island inlet, Montauk, Block island, Watch Hill, Point Judith, Boston light, Beavertail, Gay Head, Great Point, Cape Cod, Cape Ann, Isle of Shoals, Thatcher's island, Cape Elizabeth, Mount Desert, &c., &c.? Is there any reflector light on the coast of the United States equal to Boston light?

A. Boston light is superior to any other reflector light that I am acquainted with. This, however, is not owing to its superior reflectors, or to its having better care, but is mainly indebted to its presenting in one view, when it revolves around, the full power of seven lamps; whereas, in fixed lights, you do not have the full power of more than two or three at the most. There is scarcely any comparison with many of the lights you have mentioned, with Sankaty Head or the Highlands light.

Q. Was not the Boston light, when first fitted up with English reflectors, the best light on the whole coast?

A. I think it was.

Q. Do you follow particular instructions? from whom given? or do you act in all matters according to your own discretion? What tests are employed for the oils previous to receiving them on board of your vessel?

A. As a general thing, it is left discretionary with me to make such repairs to the apparatus as I may think necessary, and also in the delivery of supplies.

Q. When are the casks tested and gauged?

A. Generally, as soon as the oil is tested and accepted by the inspector (either the whole or a part) it is carted alongside of the vessel and taken immediately on board. The oil is generally inspected in the yards or sheds of the contractor. Sometimes a part of the oil remains in the sheds after the inspection, all night.

Q. What modes are employed for testing the quality of the oil? Describe the operation in detail, and also the standard up to which the oil must come in point of quality?

A. The weight of the oil, that is, its purity, is ascertained by the oleometer; winter oil is required to stand limpid at 30°, and spring at 45°. A jacket lamp is then filled from every cask, and if the lamps burn free for ten or twelve hours, without crust, or with but little crust, it is accepted.

Q. How long is the oil tested generally before you take it on board? Where is it kept during the interval of time?

A. We generally take it on board as soon as possible after being inspected; sometimes take it all on board in a day; and, as I have already stated, sometimes it lays in the yard or shed all night, and in most cases it is as safe from being adulterated there, as anywhere.

Q. Are the same tests employed for the oil for the United States as those used by the oil-dealers generally?

A. The same and only tests employed, except burning.

Q. What has been the price of the best winter-strained sperm oil for the last five years? What the price of whale oil for the same period of time?

A. The average price for crude sperm oil for five years, has been as follows:

1850	-	-	-	-	-	-	-	\$1 20 $\frac{7}{10}$	per gallon.
1849	-	-	-	-	-	-	-	1 08 $\frac{9}{10}$	"
1848	-	-	-	-	-	-	-	1 00 $\frac{5}{10}$	"
1847	-	-	-	-	-	-	-	87 $\frac{7}{8}$	"
1846	-	-	-	-	-	-	-	88	"
1845	-	-	-	-	-	-	-	90 $\frac{5}{10}$	"

Winter oil is generally about the price of crude oil.

Q. Are not blackfish oils, whale oils, and sperm oils easily mixed, difficult of detection by the ordinary tests, but easily detected by burning, owing to the charring of the wick?

A. The mixture of blackfish and sperm oils are more easily detected by the oleometer than by burning. But whale and sperm are the opposite; neither of them can be mixed or adulterated to scarce any degree, without detection.

Q. Is there any charring of the wicks with good sperm oil?

A. I believe there is not; but such oil is now very scarce, owing probably to the great length of time that it remains on shipboard after being taken. When it becomes old, and especially if it has been much exposed to the air, its burning qualities are injured, and cannot be reclaimed.

Q. How long ought the best sperm oil to burn in a common jacket lamp, or capillary-action lamp? how long without being trimmed, in a perfectly ventilated room?

A. New oil from a well-fed whale, properly tried out and manufactured, will, in my opinion, burn almost any length of time without crusting. I have known oil to burn all night, say twelve hours, the wicks remaining as soft and pliable as when first lighted.

Q. Do not inferior oils cause the wicks to become charred in a very short time, while good sperm oil does not at all?

A. They do.

Q. Are you not aware that bad articles are frequently supplied to the light-keepers, who have no means of getting them exchanged, owing to the length of time that must elapse before your return?

A. I am not. Keepers generally, on reporting these staple articles poor, such as oil and wicks, have them supplied by the superintendents, and that quite soon; although there are cases where they are under the necessity of burning their poor oil, because good cannot be procured; and if it could, some time must elapse before it could be sent, or before they could obtain it.

Q. Do not the keepers frequently complain of the bad quality of the tube-glasses or chimneys?

A. They do, and have very good reasons for doing so; but there is generally more complaint about the form.

Q. Are not many broken, in consequence of the bad quality of the article?

A. There are many.

Q. Are the lights not frequently bad, in consequence of the bad shape of the chimneys?

A. Lights would be better, no doubt, with proper shaped chimneys.

Q. Are not all the light-houses deficient in closets, store-rooms, &c., for keeping the tube-glasses, polishing powders, spare articles, &c.

A. Very few of the light-houses have closets, for the reason, no doubt, that the size of the tower will not admit of any, and if it would, they leak so badly that nothing could be kept dry for any length of time in most of them.

Q. Would it not be very easy, under a proper system, to afford the keeper many facilities for keeping the lights well, which they are now deprived of, at a very small expense?

A. Probably it would.

Q. Are not light-keepers generally very deficient in information, as to the proper manner of keeping their lights, in consequence of the absence of a proper system of instruction, inspection, and superintendence?

A. I think there is, but it is generally among new keepers.

Q. Does not the present mode of keeping lights tend generally to encourage laziness and indifference in the keepers?

A. I suppose it does; for if a poor keeper once gets appointed, it is hard work to get him out until a change in the administration, and then perhaps his friends will interfere, or he will change his politics so as to keep himself in.

Q. Would not a rigid system of inspection and superintendence tend greatly to improve the condition of the lights?

A. It is my opinion that it would.

Q. What class of men keep the cleanest light-houses and the best lights?

A. It is very difficult to say, or which to prefer, landsmen or seamen. I find good and bad in both classes; however, of the two classes, I prefer seamen.

Q. Can any seacoast light be said to be properly kept when the keeper is allowed to leave it during the night? Ought not each seacoast light to have the constant attendance of a person in the lantern, from sunsetting to sunrise?

A. In the strict sense of the word, I presume they cannot.

Q. Would it not be better to deliver the oil and other supplies at shorter intervals of time, to enable the keepers to have bad articles exchanged for good ones?

A. I should feel in hopes that, under a well adjusted system of light-keeping, &c., such things would not exist.

Q. Which lights are kept best; those on the southern coast which are seldom visited, or those on the eastern coast, in the neighborhood of large cities?

A. Those north of the Chesapeake bay.

Q. Does not the present mode of repair of towers, &c., greatly increase the annual expense of the establishment, without any equivalent in return?

A. I cannot say that they do; it is very necessary to repair them to keep

them tight; and until better towers are built, the mode of repair, &c., must continue.

Q. How much bad oil do you receive, on an average, per annum, from the different keepers?

A. Probably from 1,000 to 1,500 gallons; this includes the sediment oil, taken from the bottom of the oil butts, and the green oil or drippings from the lamps.

Q. As a general rule, do not the keepers burn all the oil before the return of the oil vessel?

A. As a general rule, we invariably find oil in the light-houses at our annual visits.

Q. Are not many incompetent and inexperienced persons appointed as keepers to light-houses?

A. There are.

Q. What length of time ought a man to serve under a well-drilled keeper, before being entrusted with a light?

A.—It would take a man three months to be properly instructed.

There have been great improvements in the lights within ten or twelve years; but still, much remains to be done. Several of the lights, I think, ought to be altered from fixed to revolving; such as Cape Hatteras, Lookout, Cape Fear and Cape Romain, for the reason that such lights can be seen much further than a fixed light. Change the harbor lights that are revolving to fixed ones. Some light-houses have power of light sufficient to be seen fifteen miles, when the tower will not admit of more than ten, and vice versa. Lights are much better kept now than they were ten years ago, but still greater care and attention is much needed.

It is my opinion that the French flash light will answer the best purpose for all our principal capes and headlands, say for instance, Cape St. Blas, Cape St. George, St. Marks, Tortugas keys, Cape Canaveral, Cape Romain, Cape Fear, Cape Lookout, Cape Hatteras, Chincoteague, or properly Assateague, besides a few others that might be named.

You will please excuse me for not being more explicit and definite in my answers, for I have done just about as well as I know how.

Respectfully, your obedient servant,

JONATHAN HOWLAND.

C—No. 20.

TREASURY DEPARTMENT,

Fifth Auditor's Office, November 2, 1837.

SIR: * * * * * “But I think the intention of the law to place it upon a house, is manifest, from the fact that revolving lights are never placed upon light-boats; and, indeed, it would be altogether impracticable.” * * * * *

Respectfully, &c.,

S. PLEASANTON,

Fifth Auditor and acting Commissioner of the Revenue.

Com. CHARLES MORRIS.

APPENDIX D.

RELATING TO SANDY HOOK LIGHT-SHIPS.

D—No. 1.

To the Honorable Commissioners of Lights, &c. &c.

GENTLEMEN: I have taken the liberty to commit to paper some views respecting the Sandy Hook light ship; also some facts which I think should be made known to your honorable body. Ever since this ship has been moored on this wild and dangerous station, it has been a yearly and sometimes twice-a-yearly occurrence, for her to break away from her moorings; and, owing to her incapacity to help herself in this dangerous situation, which usually happens in some terrific storm, she is left almost entirely at the mercy of Providence for her own safety and the safety of her crew. It has also always cost the government six or seven hundred dollars to have her towed into port or replaced at her station. If you will but look at the model of this ship, you will at once perceive that her broad bluff bow is not at all calculated to resist the fury of the sea, which, in some of the heavy gales we experience in the winter season, break against and over us with almost impending fury. The ship is getting very old and rotten, and though recently repaired, is not at all able to stand the gales of another winter, or even one such as we experienced in April last, when she shook, and trembled, and leaked to such a degree that we thought it impossible for her to survive the tempest. I would suggest the propriety of building a new ship for this station; and if I might, from my experience, be permitted here to express my views respecting her model, I should say, a ship twenty feet longer than this ship, with a partially flat floor, something similar to the ocean steamers, a clean run and a long sharp bow, which would enable her to gradually receive and cut the seas, without bringing so much strain on her moorings as she does at present. I would also suggest that she should be rigged with three masts—fore, main and small jigger masts—her lower, fore and aft sails to be sufficient for a storm, and to have long sliding gunter top-masts, to be kept housed while at anchor, but always ready to heave on end in case of emergency, and to spread nearly as large gaff-top-sails as the lower sails, to enable her, when blown off the coast, to help herself and return to her station, without incurring the enormous expense and imposition this ship has always been subject to on like occasions. The model of the present ship and her bottom, is similar to a barrel; she is constantly in motion, and when it is anyways rough she rolls and labors to such a degree as to heave the glass out of the lanterns, the beds out of the berths, tearing out the chain-plates, &c., rendering her unsafe and uncomfortable. I would also respectfully call your attention to her lanterns, which have been very much complained of, owing to their being of the most common kind, without reflectors, and entirely too low to answer the good purpose for which they were designed. It is almost invariably the case, that foreign vessels run for this light in thick weather, to obtain information respecting the tides, the bearings and distances of the bar, and also to get a correct departure. The ocean steamers frequently run for us, for the same purpose, and most of our own pilots, and all complain that the lights are too low and cannot be observed until close aboard the light ship. I would also call your attention to the manner in which our crew live. In the first place, there are no provisions on board for ships in dis-

tress, neither for pilots, which I am often obliged to receive from outward bound vessels, and supply at my own expense. The men are allowed a ration of salt provisions, amounting to twenty cents per day, weighed out to me minutely by the contractor, without any allowance for leakage, &c. They have never any fresh meat or vegetables, and cannot change off with the contractor for less than twenty-five per cent. The amount of twenty cents per day, under the management of the master, would give the crew fresh meat and vegetables twice a week, and render them far more comfortable than at present. I will not enter into the history of scurvy and other diseases that sometimes prevail among the crew, but submit this simple statement to your consideration, trusting you will attribute my motives solely to be for the good of the government, the welfare of the mariner and the comfort of those who are stationed here.

I am, with the greatest respect, your obedient servant,

HENRY I. LUNT,

Captain of Sandy Hook light vessel.

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D—No. 2.

OFFICE OF ATLANTIC MUTUAL INSURANCE COMPANY,

New York, October 13, 1851.

SIR: In answer to your inquiry relative to light-houses, beacons and buoys in the harbor and vicinity of New York, I would say, that I think the light-ship is in the right place, and that it is of immense importance to the commerce of New York that she should be kept there. Her lights could probably be much improved, and she could be furnished with a much larger bell, both of which would add very much to her efficiency, if they could be kept in order and used at the proper time. The lights in the harbor are, as far as I know, all very well; but I think the entrance to our harbor could be made much safer and much more convenient, by erecting a good light on the southeastern part of Romer shoal. Relative to buoys, I think the system, as at present existing, is about as good as any that could be devised, if said system could be properly executed. They have, as I understand it, two sets of buoys—one, for ice time, which are simple spars, painted different colors, and anchored by one end; the other set are can buoys of good size, and likewise painted of different colors. These buoys should be shifted at the proper time, and much attention should be paid to keeping them in their proper places; for it is obvious that if they are suffered to be out of place, they will do much harm. * * * I likewise think that Fire Island light could be very much improved, by being made higher and adopting the French refractors. There is another thing which, in my opinion, would very much improve the navigation of a part of our coast, and add very much to the safety of vessels bound to New York. The coast of Long Island is so similar in appearance from the sea, that the most experienced navigators are frequently very much deceived in their whereabouts on making the land. To remedy this, I think it would be very desirable to have the island marked by beacons and lights, so as to designate the exact part of the island as seen from sea. This could be done by erecting large spars at each of the United States boat stations, so as to

designate their number, viz: No. 1, one spar; No. 2, two spars; No. 3, three spars, &c.; and then for night-marks build two light-houses (with different colored lights) at equal distances from Montauk and Fire Island. These marks, properly put on the charts, could hardly fail to show the mariner how far down the island he was.

Yours, respectfully,

SAML. J. WARING,

Inspector Atlantic Mutual Insurance Company.

T. A. JENKINS, Esq.,

Secretary to Light-house Board.

APPENDIX E—Nos. 1 to 70.

REPORTS OF HYDROGRAPHICAL OFFICERS OF THE COAST SURVEY, ON
LIGHTS AND OTHER AIDS TO NAVIGATION.

E—No. 1.

COAST SURVEY OFFICE,

December 1, 1851.

SIR: I have the honor to transmit the replies made to a circular letter, addressed to me, and enclosing a copy of your communication relating to light-houses, &c., by the following named officers of the navy, chiefs of hydrographic parties on the coast survey:

Lieutenant Charles H. McBlair, commanding steamer Bibb.

Lieutenant S. Swartwout, commanding brig Washington.

Lieutenant J. N. Maffitt, commanding schooner Gallatin.

Lieutenant John Rodgers, commanding steamer Hetzell.

Lieutenant J. J. Almy, commanding steamer Legare, and

Lieutenant T. A. Jenkins, commanding steamer Corwin.

Yours respectfully,

A. D. BACHE,

Supt. U. S. Coast Survey.

Lieut. T. A. JENKINS,

Secretary to Light-house Board.

E—No. 2.

COAST SURVEY STATION,

MOUNT PLEASANT, MAINE, July 30, 1851.

SIR: I have to call your attention to the enclosed communication from the Secretary of the light-house board, and to ask such information in relation to the subjects embraced in it, as your especial experience on the coast survey, or general experience as a seaman, may enable you to furnish. I would suggest that specific answers be framed, when the subjects come within the range of your experience, to the questions addressed, adding such remarks as the introductory part of the letter seems to contemplate. Please address your reply, as a report, to me, at Portland, Maine.

Yours respectfully,

A. D. BACHE,

Supt. U. S. Coast Survey.

TO CHIEF OF HYDROGRAPHIC PARTIES OF COAST SURVEY.

E—No. 3.

[Circular.]

OFFICE LIGHT HOUSE BOARD,
July 15, 1851.

SIR: By direction of the light-house board, I have respectfully to request to be furnished any information relating to the present condition of the lights and other aids to navigation on the coasts of the United States, which you may be able to procure from the officers of the coast survey under your superintendence, together with any suggestions for the improvement and extension of the present light-house establishment, which may be deemed important, to aid the board in the performance of its duties under instructions from the Hon. Secretary of the Treasury.

Permit me to suggest as special subjects:

1. The brilliancy and useful effect of the Sankaty head or Navesink light, in comparison with any other sea-coast lights with which the officers addressed may be familiar, specifying by name the different lights thus compared.

2. The brilliancy and useful effect of the Sankaty Head or Navesink light, in comparison with the English lights on the Bahama banks, and the light on the Moro castle at Havana.

3. A comparison of the reflector sea-coast lights of the United States in general, with the Sankaty Head or Navesink lights, and with the light at Havana.

4. A comparison of the lights and other aids to navigation on the coast of the United States, with foreign lights which may have been seen.

5. Additional lights, buoys, beacons, &c., that may be required to render navigation safe and easy.

6. Improvements, if any, which particular lights may require, to render them equal to all the wants of commerce and navigation in their respective localities.

7. Changes, if any, which may be deemed necessary in the distinguishing characteristics of particular lights now existing, to prevent one being mistaken for another.

8. The best size, form and color of buoys and beacons, in general, for the coast, bays, harbors and rivers.

9. Leading or sea-marks for entering narrow channels and harbors, difficult of access, specifying the different colors and forms proper for the different back grounds upon which they are to be projected.

10. Suggestions as to the best form or shape for sea-marks for isolated dangers; shape, size, numbering and other distinguishing marks of buoys, to distinguish one from another, at the distances proper to see them in particular localities.

11. The proper distinguishing marks for particular lights, to enable the mariner to distinguish the towers by day from others in the vicinity, at as great distances as they may be visible.

I am, very respectfully, your obedient servant,

THORNTON A. JENKINS,

Lieut. U. S. Navy, and Sec'y to Light-house Board.

Prof. A. D. BACHE, LL. D.,

Supt. U. S. Coast Survey, &c., &c.

E—No. 4.

Lieutenant McBlair's letter.

U. S. SURVEYING STEAMER BIBB,
New Bedford, August 28, 1851.

SIR : I have received your letter of the 30th ultimo, directing my attention to the enclosed communication from Lieutenant Jenkins, relating to the light-house board, on subjects belonging to improvements in the navigation of our coast. I regret that my past observations of such subjects as engage the notice of the board have neither been sufficiently extended nor accurate to furnish results of much value.

Some years have passed since I have employed opportunities of seeing foreign coasts, and my knowledge of our own is very much confined to the parts I am surveying, and such points as have casually fallen under my examination, during my connexion with the survey.

It affords me, however, great satisfaction to contribute in any degree towards assisting the board in its labors.

In fulfilling this duty I will follow the special subjects cited in the letter of Lieutenant Jenkins, in their regular order, and offer such comments or suggestions as may seem pertinent and useful.

1. "The brilliancy and useful effect of the Sankaty Head or Navesink light, in comparison with any other seacoast lights with which the officer addressed may be familiar, specifying by name the different lights thus compared."

I am not sufficiently familiar, either with the Navesink or other lights along our own or foreign coasts, to draw close and careful comparisons. The lights I recollect most distinctly are those at Havana, Key West, Double-headed-shot key, Great point, (Island of Nantucket,) and those generally along Buzzard's bay, the Vineyard sound, and the coast of Cape Cod. It may be said, in general terms, that the light at Sankaty Head is superior, in various degrees in point of "brilliancy and useful effect," to all which I have enumerated, with the exception, perhaps, of the light at the Moro, with which last it seems in every respect equal.

2. "The brilliancy and useful effect of the Sankaty Head or Navesink light, in comparison with the English lights on the Bahama banks, and the light on the Moro castle at Havana."

The foregoing embraces all I can say under this head.

3. "A comparison of the reflector seacoast lights of the United States in general, with the Sankaty Head or Navesink light, and with the light at Havana."

I should think that the reflector seacoast lights are generally inferior to the Sankaty Head and Havana lights, in respect to visibility at great distances, and in brilliancy, distinctness, and useful effect when seen.

4. "A comparison of the lights and other aids to navigation on the coast of the United States with the foreign lights which may have been seen."

I can add nothing under this head to the comparisons I have already drawn.

5. "Additional lights, buoys, beacons, &c., that may be required to render navigation safe and easy."

The following objects seem to me worthy of the consideration of the light-house board :

a. The expediency of substituting a light-house on the ledge called "Sow and Pigs," standing near the entrance into Buzzard's bay, for the present light-boat moored in that vicinity, and the light-house on the western side of Cuttyhunk island. The ledge in question is said to be capable of affording a solid foundation of rock for such a structure, and a light of the highest range and power at this point would be invaluable to vessels passing into Buzzard's bay, the Vineyard sound, or bound westward into Long Island sound.

b. The expediency of constructing a breakwater at Great point, (Nantucket island,) to afford secure shelter to vessels in northerly and northwesterly storms. A very large portion of our commerce would be benefited by this improvement; especially those vessels navigating the sound. A project of this kind was some time ago entertained by the government, and a local examination made; but no subsequent measures were taken.

c. Placing a floating beacon, with a fog-bell attached, on Davis's new south shoal. This shoal lies near one of the most frequented parts of the ocean, and has occasioned some very disastrous wrecks. It has as little as eight feet of water upon it; is swept by very strong tides; and, during the summer months, is almost constantly hidden by fogs. It was designed at one time to erect a beacon upon it; but the great difficulties of the undertaking, arising from the character of the climate and the distance of the nearest port, seem to be regarded as insuperable. It is, however, indispensable to the safety of passing vessels that it should be marked in as distinct a manner as circumstances will admit.

d. A buoy-boat (hereafter to be described) on the Great rip, one of the most extensive of the Nantucket shoal—a suitable place for this mark would be in the slue or passage near the south end. I would here indicate the shoal itself, the passage in which it was moored, and that on either side of the rip.

e. A buoy boat on the small shoal lying to the eastward of the northern end of the Bass rip (Nantucket shoals) to mark the shoal itself and indicate the passage generally between the Bass and Great rip.

f. A spar buoy (hereafter to be described) on the land spit projecting from Foo's point, (Nashanna island) at the southern entrance into Quick's hole. This channel, connecting the Vineyard sound with Buzzard's bay, is constantly used, and the want of a mark showing the spit has occasioned frequent wrecks.

g. A light-boat near Brenton's reef, at the mouth of Newport harbor, already recommended in a special report to you.

h. Three small harbor lights to facilitate the entrance into Holmes' Hole harbor, already particularly described in my report to you of the 16th ult.

i. Certain spindles, buoys, and beacons, marking the approaches near Dorchester and Boston, already enumerated and described to you in my reports dated March 1.

j. A wooden beacon painted black, on Long Island, (Boston harbor) placed so as to range with the northeast end of Spectacle island, for the safe navigation of the *main* ship channel. For particulars respecting this mark, I beg to refer you to Lieutenant Charles H. Davis's report to you on the subject, of December 21, 1847.

k. A similar beacon on the southeast part of Long Island, (Boston harbor) to range with "Nix's Mate," in order to facilitate the passage through the Broad sound, south channel. In the Coast Survey Sailing Directions,

the range that has been given, to answer the same end, is "Nix's Mate on Blue Hill;" but owing to the distance of the latter object, this guide is only available in clear weather. The substitution of the beacon on Long Island for blue hill, is recommended at the instance of Lieutenant Davis.

l. A buoy boat on the southwest end of Billingsgate shoal, (Massachusetts bay) and two spar buoys on the southern edge of the shoal, planted at regular intervals between the boat and Billingsgate island. Three guides are necessary in the approach to the anchorage under Billingsgate shoal.

m. A spar buoy on or near a small rock lying to the southward of Wellfleet harbor, and called on the Hydrographical Sheet, "Belt Rock."

6. "Improvements, if any, which particular lights may require to render them equal to all the wants of commerce and navigation in their respective localities."

The position of the lights at Chatham will require some change since the formation of the new passage. The new sites will best be determined by the recent survey made of that locality by Lieutenant Woodhull.

7. "Changes, if any, which may be deemed necessary in the distinguishing characteristics of particular lights now existing, to prevent one from being mistaken for another."

I cannot suggest any change with respect to the lights with which I am familiar.

8. "The best size, form, and color of buoys and beacons, in general, for coasts, bays, harbors, and rivers."

For shoals, spits, reefs, &c., in exposed parts along the coast, I would recommend the description of buoys known in this section under the name of buoy boats. They are stoutly timbered boats, covered with a deck made impervious to water, of about four tons burthen, about twenty feet long, with seven feet beam, and supporting a mast about twelve feet high, at the head of which a tufted branch of cedar or pine is secured. This tuft is preferable to more solid substances, as offering less resistance to the wind. When securely moored, these boats ride through violent gales, and if accidentally capsized, can be easily righted. The advantage of them over other kinds of buoys, lies in their watching in the strongest tides, being visible at a greater distance, and being more striking and distinct objects at all times.

In more sheltered spots, the ordinary spar-buoys answer a useful purpose. Those used in the waters of this vicinity are from eight to ten inches in diameter at the butt, with a length dependent on the depth of water, and are secured to blocks of granite weighing from two hundred to four hundred pounds by iron shackles. They swing, of course, in an inclined position, with their heads lifted at a vertical distance of about eleven feet above the level of the water. A branch of cedar, secured at their heads, make them visible, under favorable circumstances, about three miles.

For crowded harbors or passages, where vessels are liable to foul such buoys, or in places where the depth of water forbids their use, the can buoy, as yielding more readily to pressure, is preferable—the size depending upon the distance at which it is desirable to see them.

The existing regulations of the Treasury Department, respecting the coloring and numbering of this last description of buoys, seems to furnish all the necessary means of distinguishing them. As the spar-buoy, however, does not offer a sufficiently extended plain, in any one direction, to be conveniently numbered, they can only be distinguished by the coloring, employing

for this purpose the black or red color, either singly or in combination with each other, or with white, as occasion may require. The black and red are always much more distinct, when seen near the surface of the water, than the white, and should therefore always preponderate, using the white only for the sake of variety.

9. "Leading or sea-marks, for entering narrow channels and harbors difficult of access, specifying the different colors and forms proper for the different back grounds upon which they are to be projected."

I have known natural objects, not particularly conspicuous in themselves, converted into useful beacons by very simple expedients. *Trees* given a peculiar shape by lopping or trimming, or detached from a group by clearing away the neighboring trees; or *rocks* given a white or black coloring, are both sometimes made subservient to the purposes of navigation. I can suggest no general rule as to form, for artificial beacons, except that it should be such as to distinguish them in a marked manner from other structures in their vicinity.

The selections of suitable colors is a subject of more difficulty; I should think that, speaking generally, objects are most conspicuous when bearing the color most opposed to that of the back ground, on which they are projected. When occupying eminences with a sky background, it would be useful to paint them sectionally with different colors, so that more or less contrast will always occur with the varying color of the heavens. To this end, *red*, *white*, and *black*, with the varieties they afford by being used in combination, might be employed with good effect. It frequently happens that objects of a pure *white* when standing in the same direction as the sun from the observer, fade entirely from view at a very short distance. This would seem to suggest that when marks are placed in an eastern or western direction from the point where their visibility is not useful, a combination of black or white would be serviceable in preserving their distinctness in the morning and evening: the white reflecting more vividly the rays when the sun is opposite, and the black when the sun is in the rear.

10. "Suggestions as to the best form or shape of sea-marks for isolated dangers; shape, size, numbering, and other distinguishing marks of buoys, to distinguish one from another, at the distances proper to see them in particular localities."

Where isolated rocks exist, reaching above low water level, iron spindles surmounted by tin cones make very striking marks. Shoals of the penetrable kind, such as are composed of clay, sand, &c., in localities where the pile driver can be used, may be easily indicated by spars driven to sufficient depth to resist the violence of the sea. In many cases, too, I have no doubt that the hollow iron tube, called the pneumatic pile, would prove valuable.

These marks, added to the buoys already described, are all that occur to me as noticeable under this head. They are all susceptible of being distinguished in the same manner as buoys, by differences in color.

11. "The proper distinguishing marks for particular lights, to enable the mariner to distinguish the towers by day, from others in the vicinity, at as great distances as they may be visible."

Different localities are sometimes distinguished from each other by the number of towers and lights marking each. This mode of distinction is applied with good effect on the coast of Massachusetts; Chatham being marked by two, and Nausett by three towers and lights. This method is objectionable from its expensiveness; but evidently answers the end in view

better than mere distinctness in color, which cannot, generally, be discriminated until some time after the object is first seen. The latter distinction, however, could be very carefully employed on various parts of our coast; the black, red, and white colors furnishing all the varieties that may be desirable. I see no reason why these colors could not be as effectually used to distinguish light-houses as buoys.

I have had, during my survey of the Nantucket shoals, frequent opportunities of observing Sankaty Head light, which is taken by Lieut. Jenkins as one of his standards for comparisons, and will not close this communication without again expressing my conviction that, for all the purposes for which a light is established, it is surpassed by none that I have ever seen. The flashes are very full, vivid, and striking, and have been seen by one of the vessels of the party, under circumstances not particularly favorable, from a distance of twenty-three miles. How much further the light is visible, I have had no means of ascertaining. You are aware that the white flash takes a reddish hue within the limits of seven miles from the head; but although this tinge is observable, it is not sufficiently marked to be likely to fix the attention of the navigator. Perhaps the apparatus is susceptible of some improvement in this respect.

In conclusion, I may venture to suggest that an annual publication, under the authority of the Treasury Department, of lucid and ample descriptions of the various lights, beacons, and buoys, &c., scattered along our coast, as auxiliary to the more special sailing directions proceeding, as the work advances, from the coast survey, would conduce largely to the safety of life and property, and the general interests of commerce.

Respectfully,

C. H. McBLAIR,

Lieut. Commanding and Assistant, Coast Survey.

Prof. A. D. BACHE,

Supt. U. S. Coast Survey, Portland, Maine.

E—No. 5.

Lieutenant Swartwout's Letter.

U. S. BRIG WASHINGTON,

Off Nantucket Bar, September 4, 1851.

SIR: Your circular letter, dated July 30, enclosing a communication from the Secretary of the light-house board, asking for information in relation to several subjects embraced in eleven specific interrogations, reached me in due course of mail; but my time has been so much engrossed with my duties here, that I have not had leisure until now to fully investigate and consider the many important subjects to which my attention has been called.

I regret that I shall not be able to throw much light upon the subjects in question, as my experience on the coast survey is very limited, being confined to only a part of this season, and exclusively to this section of the work; and more especially as I have never had occasion, until now, to turn my attention particularly to the subjects alluded to. I will, however, most cheerfully furnish such information as I have been able to obtain du-

ring the short time I have been attached to the coast survey, and which I think may be serviceable to the light-house board, and shall be happy also to submit any suggestions predicated upon my general experience and observation that may appear to me to be of practical utility.

Agreeably to your suggestion, sir, I will reply to the questions propounded, *seriatim*.

Question 1. The brilliancy and useful effects of Sankaty Head or Navesink light, in comparison with any other sea-coast lights with which the officers addressed may be familiar, specifying by name the different lights thus compared.

Answer. I am free to confess that I consider Sankaty Head light not only one of the most brilliant, but decidedly the most useful on the whole range of our coast. There is none more important, and, I will venture to assert, of superior brilliancy, in any part of the world, so far as my observation and information have obtained. The approach to the island of Nantucket is doubtless more hazardous and attended with greater difficulties than any other known island, in consequence of the many exceedingly dangerous and extensive shoals or reefs, situated from one-quarter of a mile to nearly thirty miles off shore, upon several of which there are not more than six feet water in many places. The currents in the vicinity of these shoals, in the course of twenty-four hours, set from as many different points of the compass, varying in velocity from one-half to three and a half knots per hour, without any period of slack water.

During the year 1844, there passed through the Vineyard sound (upon the reliable authority of William Mitchell, esq., of Nantucket,) 1,327 ships and brigs, and 10,049 schooners and sloops—total number of vessels, 11,376, which has doubtless increased every year since. This, of course, is exclusive of the vessels bound from Europe to New York, in whose track one of these most dangerous shoals (the Nantucket south shoal) is very nearly situated, and from which the Sankaty Head light is distinctly visible. Hence, in view of all these facts, the great importance and useful effects of Sankaty Head light must be apparent to every reflecting mind. I understand this light has been seen nearly forty miles seaward, under favorable circumstances. I have seen it, in this vessel, (and very distinctly too,) at least twenty-four miles distant, in a stormy night and when the atmosphere was unfavorable. The flashes from this light are intensely brilliant.

The following are all the sea-coast lights which I have seen, although I have never had an opportunity of examining any of them; but, as well as my memory serves me, feel assured that Sankaty Head light will compare very favorably with any of these. I am confident it can be seen as far as the best of them; and judging from the great protection it affords to commerce, its useful effects will be equal if not superior to the most prominent of those herewith enumerated, to wit: On the coast of the United States—Boston light, (revolving;) Newport light, (fixed;) Sandy Hook light, (fixed;) Highland lights, (one revolving, one fixed;) Barnegat light, (fixed;) Cape May light, (revolving;) Cape Henlopen light, (fixed;) Smith's Island light, near Cape Charles, (revolving;) Cape Henry light, (fixed;) Gay Head light, (revolving;) Cape Poge, Edgartown, (fixed;) Holmes' Hole light, (fixed;) Great Point, Nantucket, (fixed;) Cape Hatteras light, (fixed;) Tybee light, Savannah river, (fixed;) Pensacola light, (revolving;) Mobile light, (revolving;) Key West light, (fixed;) Sand Key light, (revolving.) Foreign lights—Bahama Banks, Moro Castle, Havana, Castle

of San Juan d'Ulloa, Vera Cruz, Island of St. Thomas, Island of Santa Cruz, St. Juan, Porto Rico, Gibralter, Cadiz, Rio de Janeiro, Bahia, Pernambuco, (Brazil,) the Island of Flores, near the entrance of the Rio de la Plata and Batavia, Island of Java, and Cape of Good Hope.

Question 2. The brilliancy and useful effect of the Sankaty Head or Navesink light, in comparison with the English lights on the Bahama banks and the light on the Moro Castle, at Havana.

Answer. Although it is many years since I have seen the Bahama and Havana lights, yet, as I saw them very frequently during a cruise of four years on the West India station, I feel no hesitation in stating, as my opinion, that the Sankaty Head light will compare very favorably with any of them, not only as regards its brilliancy, but useful effect.

Question 3. A comparison of the reflector sea-coast lights of the United States, in general, with the Sankaty Head or Navesink light, and with the light at Havana?

Answer. All the reflector sea-coast lights on the coast of the United States, which have come within my observation, I have specified in my answer to question 1st, and I am clearly of opinion that the Sankaty Head and Havana lights will lose nothing in the comparison with the best of them, and are superior to the majority of them. The Boston light, and perhaps some other revolving lights enumerated, may be larger than Sankaty Head light, yet I am satisfied that the flashes the latter emits are more intensely brilliant.

Question 4. A comparison of the lights and other aids to navigation on the coast of the United States, with the foreign lights which may have been seen?

Answer. The lights on the coast of the United States, so far as they have come under my observation, and which have been specified by me, and also the other aids to navigation, will in my opinion compare, in general, very favorably with the foreign lights I have seen, and already enumerated in my answer to question 1st.

Question 5. Additional lights, buoys, beacons, &c., that may be required to render navigation safe and easy?

Answer. I am only prepared to answer this question so far as it relates to this particular section of our coast; my attention has never been directed to any other portions of our extensive coast, with regard to these aids to navigation; and indeed, until now, I have never had an opportunity of acquiring the necessary information in relation to these important subjects. The additional aids to navigation, which seem to be required on this part of our coast, are as follows: 1st, a breakwater at Great Point (Nantucket Island.) 2d, a floating beacon, with a fog bell attached, on Davis's south shoal. 3d, a buoy-boat (to be hereafter described) on the Great rip, one of the most extensive and dangerous of the Nantucket shoals. 4th, a buoy-boat on the small shoal lying to the east of the northern end of the Bass rip, (Nantucket shoals,) to mark the shoal itself, and indicate the passage between the Bass and Great rips. 5th, a spar-buoy (to be hereafter described) on the Sand Spit, projecting from Fox's Point, (Naskema Island,) at the southern entrance, into Quick's Hole. 6th, three small harbor, or bug lights, to facilitate the entrance into Holmes's Hole. The expediency and necessity of these additional aids for the protection of our commerce in this quarter, appear to me to be very obvious; and the many disasters and shipwrecks which occur annually, from the want of them, I

flatter myself will plead strongly in favor of their immediate adoption by our government. I have merely considered it necessary to allude to these additional aids, to render navigation safe and easy, as lieutenant commanding C. H. McBlair has already very particularly recommended them to your notice, urging their useful effects by very cogent arguments, to which I can add nothing; but concurring fully with him in his views, it will only be necessary for me to refer you to his reports in relation to these matters, as an answer to this question, so far as my information extends from actual observation.

Question 6. Improvements, if any, which particular lights may require to render them equal to all the wants of commerce and navigation in their respective localities?

Answer. I am not sufficiently familiar with the various lights on our widely extended coast, never having particularly examined them, to hazard an opinion with regard to what improvements they may require. I have no doubt, however, that many of them are not equal to all the wants of commerce and navigation, in their respective localities.

Question 7. Changes, if any, which may be deemed necessary in the distinguishing characteristics of particular lights now existing, to prevent one being mistaken for another?

Answer. As far as my observation extends, with regard to the lights on our coast, it appears to me, that under the existing system of revolving, fixed, and different colored lights, they can be very readily distinguished from each other at night. I have never heard any complaints in this respect, and no other more feasible arrangement suggests itself to my mind.

Question 8. The best size, form, and color of buoys and beacons, in general, for the coast, bays, harbors, and rivers?

Answer. From my experience, I am decidedly of opinion that the only kind of buoys that can be made available and serviceable, on any part of our coast so tempestuous as this, are the boat-buoys, such as are now in use here, (and which I think unnecessary to describe, as you are doubtless familiar with their construction,) because they can be more securely moored than any other, and are discernable much further. I would recommend their adoption on our coast, generally. For the bays, rivers, and harbors, the spar and can-buoys, I should think, would answer every purpose, varying in length and size agreeably to the depth of water, and the distance it may be necessary for them to be seen. These kind of buoys are so well known, that a description of them would be superfluous. The can-buoys, of course, are proposed to be used only in rivers which are crowded with shipping, as they are more yielding in case they are run afoul of, and also in deep water where it is not practicable to make use of the spar-buoy. The beacons I would suggest being constructed of iron or stone, whichever might be deemed the cheapest, and in form resembling a light-house or pyramid. With regard to the best colors for designating buoys and beacons, there could not, agreeably to my views, be a better plan adopted than the one recommended by my highly esteemed and much lamented friend, the late lieutenant commanding George M. Bache, of the navy, (who had much experience in these matters,) in a letter addressed to the Hon. Levi Woodbury, Secretary of the Treasury, dated November 22d, 1838, published among the public documents of that year, and to which I would respectfully call your attention. I beg leave to submit the following extract from his letter, as fully conveying my ideas upon this subject.

"Some systematic mode of designating the positions of buoys would be of great utility, more especially should an increase of their number be authorized. Such distinctions as will show on which hand a buoy is to be passed, whether it be on a rock, a detached shoal, or at the end of a spit, will assist even those who may be familiar with the navigation, and are particularly serviceable in narrow and tortuous channels. To produce the best results from this, complicity must be preserved, and, at the same time, a sufficient number of distinctions introduced. I would beg leave to suggest the distinction of colors, as being the most applicable, and refer to the accompanying chart, which displays the simple combinations of colors deemed most advisable. On sailing up a sound, bay, or channel, or entering a harbor, all the buoys on spits extending from the shore, which are to be left on the right hand, are painted red; all those on the left hand are painted black. Those on rocks, or very small shoals, around which are channels, are painted with alternate red and black rings; these, as their color would indicate, can be passed on either hand. On the shoals which are included between two buoys, the lower and right hand buoys are painted with alternate red and white rings, while the upper buoys and those to be passed on the left hand are black and white. The red and black colors also indicate on which hand they should be left, the white being introduced merely to designate a detached shoal. This system is applicable to all the waters of the United States; the colors red and black have been selected on account of their showing best upon the water; and as all buoys are now painted, there can be no objection to it on the score of economy."

Question 9. Leading or sea-marks for entering narrow channels and harbors, difficult of access, specifying the different colors and forms proper for the different backgrounds upon which they are to be projected?

Answer. The best leading or sea-marks, according to my judgment, are those formed by nature, and wherever it is practicable, they should doubtless be used, in preference to any others; such, for instance, as trees, rocks, hills or mounds of earth, peculiar and striking in their forms, or grotesque in their appearance. These objects are not only discernible much farther, but are liable to be more permanent than any which could be erected by art. Where has the ingenuity of man devised sea-marks at all comparable, in their useful and lasting effects, to those with which the island of Cuba is so bountifully furnished by nature? For example, what more prominent leading marks could the mariner wish for, than the "Pan" of Matanzas, the hills of Jamco, the table land of Mariel, the hill of Cavanass, and the "Paps" of Managua, which are discernible almost as far as the island is visible, and point out unerringly where to steer for the harbors of Matanzas and Havana. Our coast and harbor pilots invariably select these natural guides in preference to any others; and the reason is very obvious, as they are more stable, more conspicuous, and less liable to be changed, than those constructed by artificial means. Where natural objects are not sufficiently conspicuous in themselves, they might be made, by a little labor and expense, prominent enough to answer very well for ranges, and reliable leading marks for entering narrow channels, and harbors difficult of access. The best forms for artificial structures, when necessary to be used as leading marks, appear to me to depend entirely upon their localities, as it is very important they should be as dissimilar as possible from any other buildings in their vicinity, in order to render them sufficiently conspicuous to answer the ends intended. When there are no natural objects which can be made

subservient, tripods, designated by being surmounted with large balls or cones, made of light materials and variously painted, might, perhaps, answer very well for ranges and leading marks, as they would be visible a long distance, and could be constructed with but trifling expense. They should, of course, be very firmly planted in the ground, in order to prevent their being prostrated by the violence of the wind. With regard to the colors proper for the different backgrounds upon which the artificial structures are to be projected, it does not strike me that any general rule can be laid down, further than that colors should be made to contrast as strongly as possible. The arrangement and combination of the colors, as well as their hues, depend so much upon the background, whether it be sky, rocks, green or sand hills, trees, and different kinds of foliage, that I should think it would be impracticable to determine the selection of the most striking colors unless the background were previously known; and even then, it seems to me it would be difficult to decide judiciously, except by actual experiments.

Question 10. Suggestions as to the best form or shape of sea-marks for isolated dangers; shape, size, numbering, and other distinguishing marks of buoys, to distinguish one from another at the distances proper to see them in particular localities?

Answer. To distinguish isolated rocks above low-water level, iron spindles, capped with tin cones, have been found to be not only very serviceable but very durable. Yielding shoals, such as are composed of sand, clay, and mud, may be easily designated by long, heavy, and stout spar-buoys driven sufficiently deep to resist the violence of the sea. In many cases, perhaps, the pneumatic pile would prove more serviceable. The distinguishing marks for these buoys could not, in my opinion, be more judiciously arranged than by carrying out the plan adverted to by me in my answer to question 8th.

Question 11. The proper distinguishing marks for particular lights, to enable the mariner to distinguish the towers, by day, from others in the vicinity, at as great distances as they may be visible?

Answer. The most feasible, although not the most economical plan which suggests itself to my mind for distinguishing the light-houses on our coast, by day, is by the number of towers. Thus designated, the mariner would be enabled, I should suppose, without any possibility of doubt, to distinguish one light-house from another, where several might be located in the same vicinity, as far as their towers may be visible. This method has already been adopted on some parts of our eastern coast, with success; but the great additional expense attending this plan would probably be an insuperable objection to its general adoption. For most sections of our coast, perhaps the other method, at present partially in use, would be found to answer every practical purpose, which is, by painting the towers red, black, or white; and by judiciously combining and arranging these colors in a similar manner as suggested with respect to designating buoys, it appears to me the towers might be made visible at a great distance, and certainly far enough to prevent the mariner from encountering any dangers. The light-house at Little Egg harbor I passed in this vessel, in May last, during the day. Its tower is painted red, and was seen by us far enough to avoid any dangers in its vicinity. This latter plan, from its trifling expense compared with the former, will doubtless strongly recommend itself to the notice of

the board, and I am of opinion that generally it would prove to subserve the wants of navigation.

Very respectfully, your obedient servant,

S. SWARTWOUT,

Lieutenant Commanding.

Prof. A. D. BACHE,

Sup't U. S. Coast Survey, Alfred, York Co., Maine.

E—No. 6.

Lieut. Maffett's letter.

UNITED STATES SCHOONER GALLATIN,

August 10, 1851.

SIR: I have received your "circular" of the 30th ultimo, enclosing a copy of a letter from Lieut. Commanding T. A. Jenkins, United States Navy, Secretary to board of light-house, &c.

In compliance with your instructions, I tax my memory in relation to past observations and comparisons of the value and relative merits of the different light-houses that have come within the limits of my cruising on the coast of the United States.

Such observations were but casually made, without the necessary experience and consideration which should render them worthy the attention the important nature of the present investigation demands. It is to be hoped that the result of the inquiry of the "board of light-houses," &c., will enable them to arrange a manual of instruction, containing such data as will direct the hydrographical officer to a uniform method of investigation, that may prove serviceable to the ends in view. I shall, to the best of my knowledge, proceed to answer the several questions propounded by Lieut. Commanding T. A. Jenkins.

1. In the summer of 1850, I was employed in the survey of the "south shoals of Nantucket," and for three months had frequent opportunities of witnessing, from sea, the efficiency of the brilliant light of Sankaty Head, without the aid of a glass; I have seen it twenty-one miles off; I know of no light superior to it, nor will the following lights compare with it, viz: Eastport, Mount Desert, Parkland, Isle of Shoals, Baker's island, Boston, Plymouth, Cape Cod, Provincetown, Chatham, Monomey, Great Point, Point Gammon, Cape Page, West Chop, Nobska, Tarpaulin Cove, Gay Head, Cuttyhunk, Round hill, Clark's Point, "Bramtale," Point Judith, Block island, Montauk point, Egg island, Dumplin, New London, New Haven, Egg island, Faulkland island, Seabrook, Throg's neck, Cape May, Cape Charles, Cape Henlopen, Cape Henry, Old Point, Cape Hatteras, Ocracoke, Cape Lookout, Cape Fear, Georgetown, Romain, Charleston, Savannah, Key West, Tortugas, Pensacola, Southwest pass, and South pass.

2. In 1842, the Moro light and the lights on the Bahama banks, were inferior to Sankaty Head light.

3. Answered above.

4. The French and English lights are, I think, *generally* superior to those on the coast of America, particularly the lights south of Henlopen,

5. I propose three sets of bug-lights for Beaufort, N. C.; first, a single light, due north of the present channel buoy; second, a range light, for crossing the bar, or for the first course in; third, a range light on "Town bank," for the second course to anchorage. Too additional buoys are also required to mark out the channel.

A bug-light *is required* for the upper jetty of the Cape Fear river. There should be three spar-buoys in Charleston harbor, one at each end of the "Middle ground," the other at "white point," to define the end of that spit, for the benefit of vessels bound up the Ashley.

A couple of beacons for a range, should be erected near "Fort Johnson," as a guide for vessels to clear "Sumpter Flats," and the end of the "middle," when bound in or out of the south city channel.

To render South Edisto serviceable as a harbor of refuge, a second order light should be placed on Seabrook point, and three buoys in the channel way.

6. Charleston light should be a "fixed light" with *improved reflectors*. No light should revolve, that is one of a range for entering a narrow channel, as the loss of it, even for a few seconds, might be attended with danger. I have frequently experienced the truth of this.

The beacon light connected with the main light should be increased in brilliancy and shifted further south, to render the range complete for crossing in the best water; a railway for *this* beacon is required, as the bar is materially influenced by southeast storms, and the range consequently changing to southward.

The "overall beacons" of Charleston harbor are useless, leading a vessel into six feet at low water. I propose that they be shifted to "Fort Sumpter," as a range for the "swash channel," one-eighth of a mile south, and with the same depth of water. This would enable coasting vessels and steamers, that now use the "north channel," to enter the harbor at night by the "swash."

A buoy is required on the southwest end of the Rattlesnake shoal. The lights at Hatteras and Romain are *very poor*; both should be overhauled and furnished with *improved reflectors*.

Bell boats would be of infinite service at the extreme point of Cape Look-out and the Fryingpan shoal.

The light-boat at Martin's Industry, S. C., should be furnished with *two* good lights, one forward, and the other aft, of different elevations; that the boat may not be confounded with St. Helena light-boat, as the light-boat on "Martin's Industry" is old, and unfit for its exposed and dangerous position, I propose that a new light-boat of great capacity, with an additional light, be placed on that shoal, and the present boat be moored off "Hitton head," Georgia, to mark the point of "Grenadier shoal," which lies due north from "Tybee light;" it is a dangerous spot, and a light-boat has repeatedly been called for by the Charleston and Savannah steamboat company.

7. Know not.

8. Outer buoys should always be the largest; the most serviceable size, thirteen feet in length, and ten feet in diameter, (as per diagram;) these are the dimensions of the outer bar buoys at Savannah. The inner buoys should be smaller. Three feet of the upper part of the outer buoy should be painted white, the rest black; a white staff and vane; middle buoy red; inner buoy black.

For harbor, *spar-buoys*; I would particularly call the *attention* of the board to the Charleston *bar-buoys*; the outer ones are entirely two *small* and badly moored, for every strong northeast wind drags them from their proper position.

9. I enclose a diagram for outer buoys, and what I consider the best form for beacons; of course, a dark back ground requires that the beacon be white.

10. Bell boats, well moored, with double or single masts, when necessary to distinguish a large well moored buoy.

11. Horizontal streaks of black and white.

I am, respectfully, your obedient servant,

JNO. N. MAFFIT,

Lieut. Commanding and Ast. U. S. Coast Survey.

Prof. A. D. BACHE, LL. D.,

Supt. U. S. Coast Survey.

E—No. 7.

Lieutenant Rodger's letter.

UNITED STATES COAST SURVEY OFFICE,

Washington, August 25, 1851.

SIR: In reply to your letter of July 30, enclosing a circular from the light-house board, making inquiries in regard to the present condition of the lights and other aids to navigation which have come under my observation, I have the honor to say:

1. "As to the brilliancy and useful effect of the Sankaty Head or Navesink light, in comparison with any other seacoast lights with which I may be familiar," that I am not familiar with the first named lights.

2. "The brilliancy and useful effect of the Sankaty Head or Navesink light in comparison with the English lights on the Bahama banks, and the light on the Moro castle at Havana?"

I am not familiar with the American lights named, nor for the last ten years with the foreign lights. The English lights on the Bahama banks were then excellent, and, owing to bad keeping, the Havana light was a miserable one.

I have been reliably informed that at one time the Navesink light revolved too fast for full useful effect. I do not know whether this has been remedied.

3. "A comparison of the reflector seacoast lights in general, with the Sankaty Head or Navesink light, and with the light at Havana." I am not able to make the comparison, but I think no one can make a voyage along the southern half of the eastern coast of the United States, without coming to the conclusion that the illuminating power is often insufficient. After a light has been reported, a doubt sometimes remains whether it may not be a ship's lantern. Occasionally the rays scarcely reach, in clear weather, the danger to be avoided.

4. "A comparison of the lights and other aids to navigation on the coast of the United States, with the foreign lights which may have been seen."

I think the lights in the Mediterranean, (generally refracting lights,) far better than our reflector lights. Because they are more powerful, the mist does not so readily hide them, and, as far as my experience goes, when seen,

the light is recognised at once as coming from a light-house. The same remark applies to the English lights on the Bahama banks. I have heard them offered as a proof that the vapor quoted as such a frequent cause of wreck, by hiding the lights on the American side of the Florida channel, has no real existence, or exists only for feeble lights.

Foreign buoys, as far as I have seen, are so well moored, that no slight force can displace them. It would often be dangerous to confide in the positions of ours. On all permanent bars the buoys should be well enough moored for warping purposes. In calms, vessels are tempted to make fast to them rather than let go an anchor: and they often hold on until the breeze shall acquire force enough to work against the tide. The danger of prosecution, from a variety of causes, is very small. It may be doubted whether a few fathoms of chain large enough for a frigate, secured by Mitchell's mooring screw, would not, in the end, be cheaper than finding buoys gone adrift, supplying lost moorings, and replacing in position those which have dragged. If useful effect and safety to commerce be taken into the account, no hesitation can remain as to the side on which true economy lies. With the proposed substitution, vessels might be permitted to avail themselves of the aid of buoys either in warping, or in riding to. Buoys would then be a double aid to navigation; now they are too often useless for any good purpose, or worse than useless.

5. "Additional lights, buoys, beacons, &c., that may be required to render navigation safe and easy." Additional lights are required on the Florida reef. The difficulties of navigation along this reef, arising from the curved shape of the channel, requiring continual change of course; the strength and irregularity of the current; the coral reefs which fringe either shore, and the lowness of the land, added to the vast amount of passing commerce and the number and value of the wrecks, call for a full illumination. I think four more light-houses and the shifting of a light-boat would be sufficient.

I would place them thus: one about Alligator reef, off Indian key; one about Collin's patches, off Key Vacas; one on Love key, and one half-way between Cape Florida and Carysfort reef. These should all be first class refracting lights, or possibly, with the latest improvements, second class.

The light-boat now on Carysfort reef might have a proper lantern fitted to her and be placed on the Rebecca shoals, between the Tortugas and Marquesas keys. The passage between the Tortugas and Marquesas keys is so much frequented by vessels bound into the Gulf of Mexico, as to call for a light-boat to point out the shoals in it.

With these lights, in addition to those now erected or in progress, vessels could scarcely get on shore on our side of the Florida channel, without having been warned by a light.

With the increased safety there seems incidental advantages. Our shore being better lighted than the opposite one, vessels will keep in our own waters in passing through the Florida channel. The wrecks inevitable to extensive commerce, will pay salvage to our citizens rather than to foreigners, and foreign goods thus introduced, pay duties to our government.

The wrecks brought into Key West amount annually to \$1,200,000, and those on the Bahama banks to twice as much.

It is a point with vessels coasting along the southern States, to keep, as far as practicable, within the influence of the gulf stream; for time is of so much importance to them, that they are willing to risk something to save

time. Coasting steamers run from Cape Canaveral shoal to Jupiter inlet, where the trend of the land alters. A light-house would be useful as a point to run for, and to indicate when the change of course had become necessary. Such a light-house may perhaps be made to guard a shoal which lies between Jupiter inlet and Indian river, on which the United States mail steamer Georgia touched. Captain Coste, United States revenue marine, knows that such a shoal exists. Captain Willey, a ship owner and master who has traded for many years along our southern coast, has furnished me with the following information: "Nine miles from land—ten miles E. by S½S. from Indian river, lies a shoal about one mile long and two cable lengths wide. It has five fathoms water on the north end, and fifteen feet on the south end—ten fathoms inside of it."

"SE½S. from Indian river, and five miles from land is another shoal with fifteen feet water on it.

"With Gilbert's bar bearing E½N., distant four miles, is another shoal with five fathoms on it.

"A rock with six or seven feet water on it, lies half a mile ESE. from the south side of Jupiter inlet; five fathoms close alongside of it."

The light-house can only be properly placed after an examination has been made.

A light-house would be useful about Hillsborough inlet, or where it shall be found that the first spur of the Florida reef starts from the main land.

In the distance of one hundred and seventy miles between Cape Canaveral and Cape Florida, there is now no light. The two I propose should both, I think, be of the first-class, unless it should be found that the recent improvements in the second-class refracting lights make them nearly equal to the first.

6. "Improvements, if any, which particular lights may require to render them equal to all the wants of commerce and navigation in their respective localities."

Over estimate of distance in consequence of dimness of the Tortugas light, is sometimes given as a cause of wreck. Its situation is one of the most important on our whole coast; nearly all the commerce of the Gulf of Mexico passes within sight of it. If additional force be needed to the requirement of a first-class light, it may be found in the military position of the Tortugas. To develope the full usefulness to commerce and the navy, of the extensive fortification now in progress there, as powerful a light as possible seems necessary.

Cape Florida has a good ordinary reflector light. Its position seems to point out as proper, a first-class refracting one. I hope it will not be considered foreign to the subject of these lights, for me to offer the suggestion that the Florida channel is the natural outlet of the Mississippi; that the lights along the Florida reef are those in which the western planters of the United States are particularly interested; and that in lessening the danger of getting their produce to market, its price to them will be enhanced.

Cape Hatteras, Cape Lookout, and Cape Fear, seem all positions for first-class lights.

The light-house on Cape Fear is, according to Blunt's Coast Pilot, 110 feet above the level of the sea. Its range of visibility to an eye eleven feet above the sea is, by calculation, 12.76 nautical miles. The Fryingpan shoals off this cape, extend twenty miles from land. An inspection of the chart shows that these shoals should be illuminated. It does not seem

practicable to give a tower on Smith island, the height necessary to be seen so far. Light-boats are placed in situations as exposed; it is possible that an examination might discover a sheltered berth for one.

In such situations, it may be sound discretion to build screw-pile or other beacons, to be left some years to test their stability; when, if they stand the test satisfactorily, the light may be placed on the beacon and the boat removed.

The light at Cape Canaveral is not sufficient. The tower was built when it was believed that the shoals extended only three or four miles from the cape. Subsequent examination has discovered a shoal with eight feet water on it at the distance of eleven nautical miles.

The light elevated sixty feet cannot be seen according to theory by an eye elevated fourteen feet above the sea, more than nine nautical miles. The tower should be raised to about 110 feet, and the light be changed to a first-class refracting one.

There is reason to believe that the formulas for calculating the range of visibility of various heights, are practically wrong. Good lights appear to be habitually seen beyond their theoretical range. A satisfactory manner of testing these formulas, should they be doubted, would be by examining in New York, the log-books of packet-ships and ocean steamers. I do not know of any good American lights on boats.

Obviously, the calculated range and power of any light should be somewhat greater than the distance from it of the danger it is intended to illuminate. This primary rule seems sometimes to have been neglected.

Lights are of so much use to coasters, that service to them seems rather the guide in establishing a plan of illumination, than regard to ocean vessels.

First-class refracting lights on important head-lands, seem a requirement of commerce; in the indentations, smaller lights appear proper, except for important harbors.

A chart would apparently be a good guide for determining the class of lights proper to each locality.

A corrected list of lights, beacons and buoys, should be published periodically by authority, as in England. If it be worth while to build and keep up these expensive establishments, certainly it is worth while to disseminate correct information in regard to them.

7. "Changes, if any, which may be deemed necessary in the distinguishing characteristics of particular lights now existing to prevent one from being taken for another." I know of no changes required.

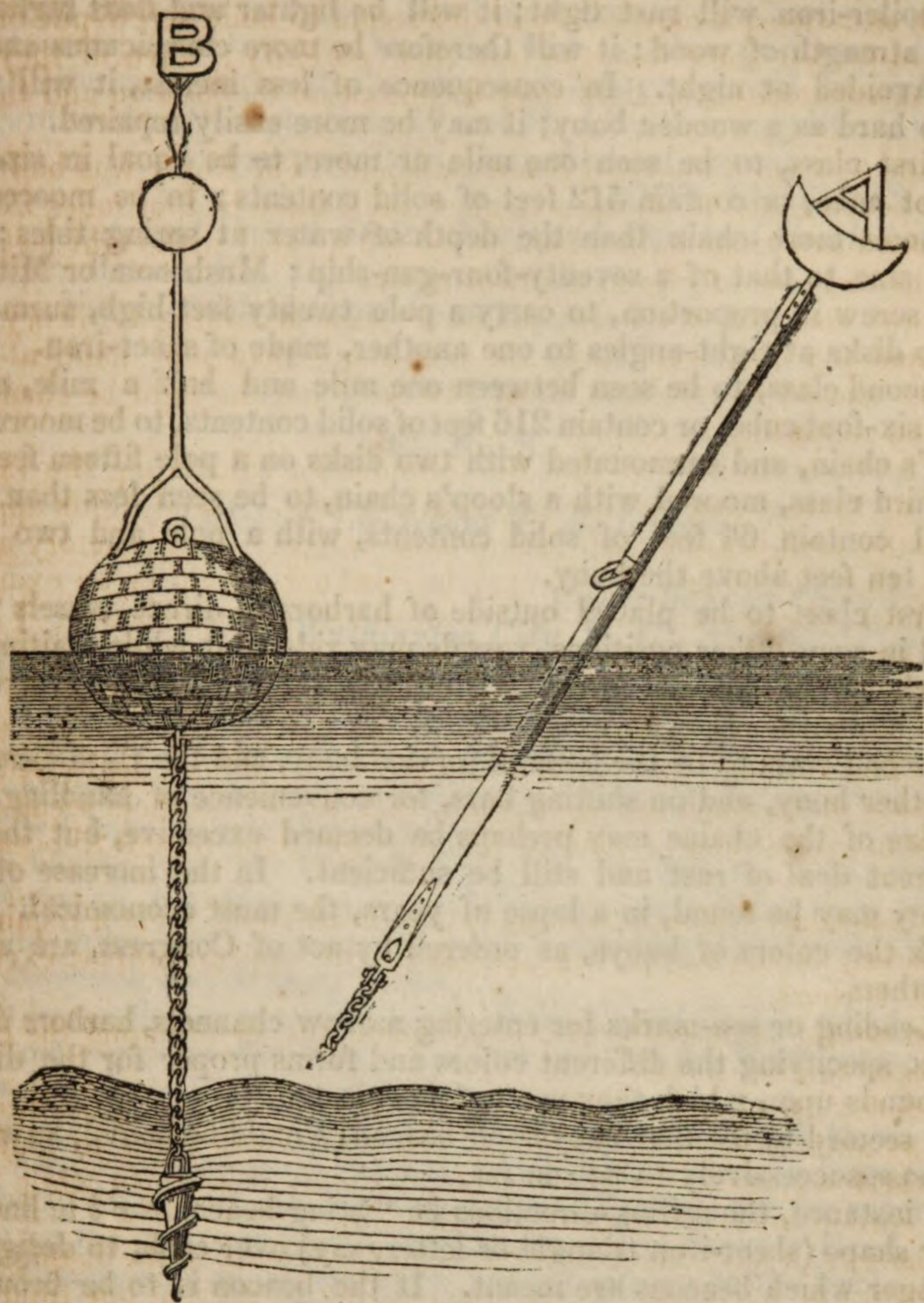
8. "The best size, form, and color of buoys and beacons, in general, for the coasts, bays, harbors and rivers."

I think three sizes might be useful, to be called first, second, and third class.

The following requisites may be sought:

1. Permanence to be attained by moorings stronger than any strain to which they are liable to be subjected. Permanence I regard as the first requisite, because a buoy out of its place may be far worse than none. It deceives the navigator as to the position of the bank or bar; with no buoy he would use means to avoid the danger, wait for a pilot, or send a boat

ahead. Moorings once put down need never be moved. When the buoy needs cleaning, shackle another in its place when the old one is removed.



2. Visibility to be obtained by size, and by its carrying a disk or shape elevated according to the class of the buoy. These shapes may be varied so as to indicate the position of the buoy; as red buoys with circular sheet-iron disk surmounting the pole; black buoys with square disks; black and white; half moons. At night the shapes might be seen while the color could not be told; and negligence in keeping the paint in good order would be of little importance.

3. General eligibility, in which are included strength, durability, tightness, adaptation to warping purposes, ultimate cheapness.

It may be worth consideration whether very oblate spheroidal boiler iron buoys may not combine these qualities.

The very oblate bottom will give stability to resist turning over, when men get on top to make fast a hawser, and yet be arched to resist pressure

on the oblate top; a man may stand, as on a platform, to bend on a rope to the shackle. The round sides will resist concussion better than the French cubical buoys, while it will be more difficult to strike them fair.

The boiler-iron will rust tight; it will be lighter and float higher than an equal strength of wood; it will therefore be more conspicuous and more readily avoided at night. In consequence of less inertia, it will not be struck so hard as a wooden buoy; it may be more easily repaired.

The first class, to be seen one mile or more, to be equal in size to an eight foot cube, or contain 512 feet of solid contents; to be moored with two fathoms more chain than the depth of water at spring tides; chain equal in size to that of a seventy-four-gun-ship; Mushroom or Mitchell's mooring screw in proportion, to carry a pole twenty feet high, surmounted with two disks at right-angles to one another, made of sheet-iron.

The second class, to be seen between one mile and half a mile, equivalent to a six-foot cube, or contain 216 feet of solid contents, to be moored with a frigate's chain, and surmounted with two disks on a pole fifteen feet high.

The third class, moored with a sloop's chain, to be seen less than half a mile, and contain 64 feet of solid contents, with a pole and two shapes elevated ten feet above the buoy.

The first class to be placed outside of harbors to direct vessels to the bar; and in some other positions, vessels may ride to it while waiting for a pilot or change of tide. If forced to go to sea, it would be a great convenience to slip rather than to weigh.

The second class to be the general service buoy, and the third class when near another buoy, and on shifting bars, for convenience of handling.

The size of the chains may perhaps be deemed excessive, but they will bear a great deal of rust and still be sufficient. In the increase of durability they may be found, in a lapse of years, the most economical.

I think the colors of buoys, as ordered by act of Congress, are as good as any others.

9. "Leading or sea-marks for entering narrow channels, harbors difficult of access, specifying the different colors and forms proper for the different back-grounds upon which they are to be projected."

It has seemed to me that buoys and beacons should be paired, so as to indicate those successively to be run for.

If, for instance, the sailing-directions be "bring beacon *a* *r* *b* in line," put a similar shape (sheet-iron triangle or letter, say) over each, to designate to the stranger which beacons are meant. If the beacon is to be brought on the light-house, a large L of sheet iron over the beacon would indicate the fact—or run for two half-moons until the squares are in line, then run for them. The boarding-house on Tucker's island is one of the leading marks for Little Egg harbor. The boarding-house should have some mark over one of the chimneys. "A remarkable tree" might easily be designated by the same means.

Where a beacon or light-house is a leading mark, it may be made to indicate a line of direction—as the towers are round, it is easily done.

If the sailing-directions be "bring the light-house to bear northwest and then run for it," paint the northwest face white and the rest black, with the black so far round as not to be seen until the vessel is on a line of danger; then, while she sees only the white face she is in the channel way, with an instant warning, when she gets out of it.

When a light-house is projected against the sky, black is, under ordinary

circumstances, the most conspicuous color for it; if against foliage, white. I have had to change surveying signals from white to black very often. The white is most conspicuous when the sun shines on it, so as to reflect the light from the tower to the eye, but it is comparatively a rare circumstance for the observer and the sun to have the best relative position. A tower projected alternately against the sky and foliage, should be light red.

In regard to the other questions 10 and 11, I have no suggestions to offer.

Very respectfully, your obedient servant,

JOHN RODGERS,

Lieutenant United States Navy and Assistant Coast Survey.

To A. D. BACHE, LL. D.,

Superintendent Coast Survey.

E—No. 8.

Letter of Lieutenant T. A. Jenkins.

COAST SURVEY OFFICE,

Washington City, D. C., November 5, 1851.

SIR: In conformity with your instructions, transmitting a circular letter from the light-house board, I have respectfully to report:

1. That the French lens lights at Navesink, New Jersey, and Sankaty Head, Nantucket, are, in point of brilliancy and range, far superior to any other lights I have seen in this country.

2. Not having seen the English lights on the Bahama banks recently, nor the light on the Moro castle, at Havana, since it has been fitted up with a first order lens apparatus, I cannot compare them with the lens lights of Navesink and Sankaty Head.

3. The best reflector sea-coast lights of the United States, which I have seen, are not equal to the third order lens light on the Brandywine shoal, Delaware Bay, in brilliancy and usefulness.

4. The lights of France, England, Scotland, Ireland, and those of the maritime nations of Europe in general, which I have seen, (a large number of them being fitted with the lens apparatus of Fresnel) are far superior to the lights on the coasts of the United States. The Sankaty Head, Navesink, and Brandywine shoal lens lights are not inferior to the lights of the same classes, in general, in Europe, although there are many of the European lights which are greatly superior to them.

The other aids to navigation, consisting of floating lights, beacons, buoys, range marks, &c., &c., in England, Scotland, Ireland, and France, are kept up in a better and more efficient manner than they are in this country.

The floating lights of the United States have lamps with large solid cord wicks, flat wicks, and, in some instances, circular wicks, fed by capillary action, and the external current of air only, to produce good combustion and a clear bright flame—an impossibility. “Before Argand’s time every wick consisted of a solid cord, whose flame was fed only by the current of air outside; and the consequence of this arrangement is, that the stream of vapor or smoke, especially from the centre of thick wicks, escapes unburnt, because, before it reaches the height at which the combustion of the central

stream can take place, its temperature has become too low to admit of its ignition."

The floating lights of the United States are all fixed lights.

In England especially, the floating lights are fitted with Argand lamps and parabolic reflectors, with a fair proportion of them revolving, as a distinction.

The buoys in the United States are too small as a general rule; badly painted, of improper shapes, and often improperly moored.

The beacons are not properly painted and distinguished from each other, and they, in general, only serve to aid those familiar with the local navigation.

5. This question cannot be fully answered by me now. Not less than four buoys are required, of a large size, to mark out the channels on the Frying-pan shoals (Cape Fear.) A light boat, fitted with the best Argand lamps and parabolic reflectors, should be safely moored in the neighborhood of the outer end of these dangerous shoals, to serve as a guide to the navigator in passing them.

6. The following lights require to be improved, and there should be no unnecessary delay in accomplishing it:

Cape May, revolving light.

Cape Henlopen, fixed.

Smith's island, (Cape Charles) revolving light.

Cape Henry, fixed light.

Cape Hatteras, do

Cape Lookout, do

Cape Fear, Bald Head, fixed light.

Cape Romain, do

Charleston, S. C., revolving light.

These nine lights are not second in importance to any on the coast of this or any other country, and humanity and true economy demand that the towers of each of them should have an elevation of one hundred and fifty feet above the level of the sea; and that they should be fitted up in the best manner with first order lens apparatus, to insure a brilliancy and range adequate to the wants of commerce.

These lights are not sufficiently well distinguished; but a general plan for all the sea-coast lights will best accomplish that object.

7. In cases where the towers remain in the natural state of color of the materials employed in their construction, and where they are uniformly white, on an extended low coast without headlands or other prominent objects to guide the mariner, they should be distinguished by colors, having due regard to the objects forming the back ground.

8. The law at present prescribes the best colors for buoys; black to port, red to starboard on entering a bay, river or port, with red, black and white stripes, according to positions and dangers to be marked.

The buoys are, in general, too small. Can and nun-buoys are believed to be the best shapes, but they require perches, numbers, &c., sufficiently distinctive at as great distances as they ought to be seen. Spar-buoys are only adapted to a few special positions, and are in general inefficient.

Well made iron buoys (both nun and can) moored with blocks, sinkers or screws of proper weights and sizes, with well tested chain cables, of proper length and size, are believed to be the most economical. Duplicates

are clearly necessary to enable the officers in charge of them to keep them well painted and numbered.

9. Red, black and white, singly and in combination, will afford all the necessary distinctions for towers and leading marks to enter intricate channels, &c., &c. A regard to the back ground must be had in all cases. Red and black show well on the water; white upon dark back grounds, the sky, forests, &c., while the sun shines, and the observer is in the position to have the benefit of the reflection; hence there may be combinations by broad horizontal and perpendicular lines, to form all the distinctions which navigators may require.

Leading lights are generally too close to each other; as examples, the two on Oak island, and the two at Price's creek, Cape Fear, may be cited.

Leading marks on land, for ranges, and all buoys should be of such forms, colors and dimensions, as to insure their special characteristics being recognized without difficulty.

The towers of all sea-coast lights, especially on low coasts, should be as marked in their characteristic distinctions by day, as the lights are by night.

Having been employed during the three past seasons in the vicinity of Capes Hatteras and Fear, in charge of a hydrographic party, I had ample means of ascertaining the general state of the atmosphere near those localities, relatively to that of other parts of our own and of foreign coasts, especially with reference to the assumed greater amount of haze, mist, &c., there, arising from their proximity to the Gulf stream, calculated to impair the usefulness and brilliancy of the lights on our southern coast.

Having learned that such an idea had been suggested, more than ordinary care and attention was given to the subject, which resulted in the irresistible conclusion that no such cause had any real existence.

The lights of Capes Henry, Henlopen, Hatteras and Fear, were seen under almost every possible state of the atmosphere; in calms, in gales, and with the wind from every different point of the compass; at the greatest distances at which they could be seen, and from the closest proximity to them.

The generally admitted inferiority of these lights can only be properly attributed to the bad apparatus employed in them, and to the want of knowledge and instruction on the part of those employed to keep and superintend them.

If additional evidence were required to prove the fallacy of the assumption that these lights are not good in consequence of the state of the atmosphere being worse than elsewhere, it would be found in the undeniable fact that the English reflector and refractor lights on the Bahama banks, (almost within sight of the coast of Florida, and the Gulf stream being equally near to all) are far superior to those on every part of our coast, with the exception of the lens lights at Sankaty Head, and the highlands of Navesink.

In replying to the queries of the light-house board, I have confined myself (so far as the questions propounded would allow) to the limits of the sphere of my hydrographic duties.

I am, very respectfully, your obedient servant,

THORNTON A. JENKINS,

Lieut. U. S. Navy and Asst. U. S. Coast Survey.

Prof. A. D. BACHE, LL. D.,

Supt. U. S. Coast Survey, &c., &c.

E—No. 9.

*Lieutenant Woodhull's letter.*UNITED STATES COAST SURVEY OFFICE,
Washington, December 22, 1851.

SIR : Your circular, enclosing a letter from the secretary of the light-house board, was duly received. Coming to hand while occupied with my surveying and sounding duties, I was obliged to defer replying till the present time.

In the nineteen years attached to the navy, the greater part of which time I have been employed on foreign service, and latterly upon the coast survey, I have had abundant opportunity to notice and compare the different lights of the Mediterranean, the French and Spanish coasts on the Atlantic, a portion of the coast of England, the West India islands, and the east coast of South America, with our own coast from the mouths of the Mississippi to Maine, and it is with mortification I am compelled to confess that our lights are strikingly inferior, with two or three exceptions, to them all. Of all the lights I have seen, the French lights are the best, the English the next, and those of nearly all the others mentioned, superior, as a general thing, to those of the United States. Our whole system as regards the illuminating apparatus and attendance, &c., (if properly it can be so called,) is faulty in the extreme, and behind the age as far as improvement and science are concerned. The reflectors and lamps now in use are insufficient and too imperfect for sea-coast purposes; however, they may answer for inland navigation. They are wanting in *brilliancy* and *power*, which the experience of years has been unable to give them. The whole system of lights should be remodelled and improved, and the Fresnel lenses and lamps substituted on the sea-coast; they are more brilliant, powerful and *economical*, and every way better suited to the demand of the navigator. If no other object is considered or desired than economy, the change should be effected. By this substitution we should gain, besides, if nothing more, the platform now occupied by France and England in this most important branch of service, and show to the world we are equal to them in adopting every suggestion and improvement which will give aid and safety to navigation and commerce.

The best lights on our coast are *Navesink*, *Sankaty Head*, and *Brandywine* shoals. All these I have had occasion repeatedly to notice and use; and I have no hesitation in saying they will compare favorably with any of the lights I have seen on the Bahama Banks, or the light on the Moro castle at Havana.

The locating and erecting of light-houses in this country, appears to me more indebted to accident than design; in many cases the lanterns are deficient in elevation, and are seemingly built and placed without the slightest regard to the peculiarities of the coast, as regards fogs, &c., they are intended to guard. On parts of our coast where fogs occur six months in the year, the light should be lower, as it frequently happens that the line of shore can be plainly seen when all about it is obscured. This is the case along the coast of Maine, Martha's Vineyard sound, and Cape Cod. I would particularly mention, as an example, the light at Fort Constitution, at Portsmouth. It is one of the cases bearing on my assertion. While surveying off the harbor, I have frequently, during the prevalence of a fog, seen the Whale-back

light distinctly, when the light at the fort was shut in. I would recommend this subject to the consideration of the board, and hope some order may be taken in regard to it.

Some improvement is required in our floating lights. The light-boats I have visited on Nantucket shoals are ill adapted to the purpose; they are too small, badly constructed, and consequently uncomfortable to live in, uneasy at their moorings, and roll to such a degree that it frequently happens *the lights cannot be hoisted more than half their proper height, and in many cases, I have been informed, could not be hoisted at all*, causing doubt and apprehension to the navigator approaching them.

For fog-signals I would suggest the use of the air-whistle in all cases when they may be required; it has a decided advantage, in all respects, over every other contrivance I am acquainted with. On the coast of Maine the bell is very little regarded, and has been found insufficient as a guide, the "*roll*" of the surf being more depended on by men of experience and judgment.

The buoys in the United States, that I have had occasion to notice, are unworthy of the name, and can scarcely be considered as a guide, except *to those acquainted with their particular localities*. They are, in the first place, too small, badly colored, and painted without the least regard to back-grounds or other equally important considerations; secondly, they want distinctiveness: something is required to distinguish the buoys and beacons that mark the limits of ship-channels from lesser ones leading into the same harbor. *Balls, urns, and crosses on top of them*, would answer better than numbering or painting them in stripes. *Can or nun-buoys, judiciously colored and distinguished, would be the best in all cases*; thirdly, the buoys under the present contract system *have become too numerous*; frequently placed where they are not required, thereby causing difficulty and confusion, rather than being guides and aids in entering harbors. The best colors for painting buoys, agreeably to my experience, are BLACK and VERMILLION red, as they can be seen at a *greater distance, and more distinctly*, than any other tints. White should never be used, except with a decided dark back-ground: *black and white, in stripes perpendicularly placed, annul each other*—so much so that buoys painted in this manner can be seen but indistinctly and at short distances. Buoys should also (as it is a matter of much importance) be so constructed and moored that they will *always "watch," ice or no ice*. In all cases there should be duplicates, to give facility to painting and repairing.

In conclusion, I would respectfully recommend that a light-house be erected between Fire island and Montauk lights. Fire island light can be seen, in *clear weather, fifteen miles* to seaward, and Montauk about the same distance in misty weather—about half that distance may be near the mark. It is a little remarkable that most of the disasters occur between these lights, and seldom or never immediately in the neighborhood—the whole shore is sprinkled with relics of these mishaps. To remedy this state of things, if not correct it entirely, is the cause of this suggestion. It should be a stationary red light, or something to distinguish it from those on each side of it, or on the Jersey shore. I have conversed with many of the most intelligent and experienced ship-masters, and other gentlemen connected with the commerce of New York, on this subject—all agree it is greatly required and would be of the utmost importance. It would give greater confidence in approaching Sandy Hook, and guard, in a great mea

sure, against the recurrence of the dreadful shipwrecks that have recently occurred in that region.

I would also recommend a light-house to be erected on the Sow and Pig's shoal, at the extremity of Cuttyhunk, entrance of Martha's Vineyard sound and Buzzard's bay; also the removal of the light-houses (wood) from the *south side of the entrance* of Newburyport harbor, to the *north side*. As they are now, they are of very little use, and would become, by the change, a real service and guide *over the new bar*—the south entrance being now very little used.

These facts, arrived at after due reflection and personal examination, I offer for what they may be worth, hoping, at the same time, that I have not stepped beyond the strict letter of your inquiry.

I am, sir, very respectfully, &c.,

M. WOODHULL,

Lieutenant Commanding U. S. Navy, and Assist. Coast Survey.

Professor A. D. BACHE,

Superintendent U. S. Coast Survey, Washington city, D. C.

E—No. 10.

COAST SURVEY OFFICE,

November 24, 1851.

SIR: I enclose herewith, for the information of the light-house board, a copy of a report from Lieut. Commanding Almy, United States Navy, assistant in the coast survey on Assateague light-house, in compliance with his request.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Lieut. Commanding T. A. JENKINS, U. S. N.

Secretary of Light-house Board.

Letter of Lieutenant Almy.

UNITED STATES COAST SURVEY, STEAMER LEGARE,

Off Wallop Island, sea-coast of Virginia, August 14, 1851.

SIR: As the chiefs of hydrographic parties upon the coast survey are required to report minutely upon the light-houses located in the sections in which they may be working, and now, having been two months in the vicinity of Assateague light-house, I hereby submit my report upon it, as the light-house board has not yet visited it.

Assateague light-house is upon Assateague island, sea-coast of Virginia. It is a structure of brick, whitewashed, located on a slight elevation of sand hills, among the pine woods, and distant from the water, at the anchorage on the south side, one mile, and one mile and a quarter from the water on the east, or Atlantic side.

The base of the lantern is forty-five feet, the centre of it forty-eight feet, and the top of the lantern fifty-one feet from the ground. The height of

the top of the lantern from low-water mark, as we assumed by an angle from the steamer *Legare*, was found to be eighty-two feet. It is a fixed light of a whitish color; metallic reflectors, with eleven burners. In clear weather it may be seen a distance of twelve miles.

Any nautical man, of the least experience, in looking at the location of this light-house, and the numerous dangers in the vicinity of it, would say that it ought to be at least one hundred feet high, with a light of the very first order. Among the dangers near and in sight of it, is the *two fathom shoal* off, abreast of Lonesome Hill, eight statute miles from the land, and twelve statute miles N. E. by E. $\frac{1}{4}$ E. (by compass) from this light-house.

The keeper of this light-house (Mr. Brattan) reports that the reflectors have been in use seventeen years. They are certainly in a bad condition; the silver rubbed off in many places, and the copper visible. He says that he is afraid to clean them as they should be done, as the remainder of the silver would be taken entirely off.

When I was lately absent from my working ground at Norfolk, with the *Legare* in dock, the contractor for supplying the light-houses with oil (Mr. Howland) came here in a vessel to deliver oil for this light-house. Mr. Brattan says that Mr. Howland had reflectors on board of his vessel for light-houses which might require them. Mr. Brattan told Mr. Howland that he wanted new reflectors put up here. Mr. Howland said he had'nt time to put them up; that this was his last light-house to supply with oil, and he wanted to get through and be off; and so he went.

After Mr. Howland had left here with his vessel, Mr. Brattan received a letter from the collector at Norfolk, saying to him, that he must not allow Mr. Howland to leave here until these new reflectors were put up. But it was too late; he had gone, and the reflectors were not put up.

I think, sir, that you will agree with me when I say that this matter ought to be looked into by the appropriate bureau of the Treasury Department.

I remain, with great respect, your obedient servant,

JOHN J. ALMY,

Lieut. U. S. Navy, Assist. Coast Survey.

Prof. A. D. BACHE,

Superintendent Coast Survey.

APPENDIX F.

*Comparative elevation of foreign and United States light-house towers,
 &c., &c., &c.*

Names.	Height of tower.	Elevation above sea level.
UNITED STATES.		
	Feet.	Feet.
Portland.....	45	80
Seguin.....	20	166
West Quoddy.....	45	90
Monhegan island.....	30	170
Owl's Head.....	15	117
Cape Elizabeth.....	50	140
Do.....	50	140
Dice's Head.....	40	116
Eagle island point.....	25	100
Bear island.....	17	95
Boston.....	60	90
Thatcher's island.....	37	90
Do.....	.....	90
Cape Cod.....	45	180
Gay Head.....	38	172
Sankaty Head.....	65	.....
Juniper island.....	30	95
New London.....	80	111
Eaton's Neck.....	50	134
Montauk.....	80	160
Sandy Hook.....	77	90
Navesink.....	40	248
Do.....	40	246
Cape Henlopen.....	72	180
Cape Henry.....	72	120
Bald Head.....	90	110 (?)
Cape Hatteras.....	90 (?)	95
Cape Lookout.....	93	95
Charleston.....	102	105
Cape Romain.....	65	87
Tybee.....	95	100
Dry Tortugas.....	65	70
Cape Florida.....	65	70
Cape May.....	68	86
ENGLISH LIGHTS.		
Scilly.....	53	138
Longships.....	36	88
Lizard.....	45	221
Do.....	45	224
Edystone.....	72	72
Start Point.....	94	204
Casquets.....	13	81
Do.....	28	81

NOTE.—This list of 35 towers comprises those of the greatest elevation of the entire number of stations (296) on the coasts of the United States. Of the remaining towers (say 261) the majority have no greater average elevation than 50 to 65 feet, while there are many having less than 30 to 40 feet. The European lists, on the contrary, comprise nearly all the sea-coast lights.

APPENDIX F—Continued.

Names.	Height of tower.	Elevation above sea level.
	<i>Feet.</i>	<i>Feet.</i>
Casquets	28	81
Portland	25	198
Do	70	131
Needles	26	469
St. Catharines	105	178
Beachy Head	20	285
Dungeness	86	92
South Foreland	41	372
Do	32	275
North Foreland	70	184
Margate	70	85
Orford	87	87
Lowestoft	42	119
Do	42	42
Haisbrough	85	187
Do	67	100
Cromer	38	274
Chapel	49	115
Spurn	90	100
Flamborough	72	214
Tynemouth	75	154
SCOTLAND.		
Inchkeith	45	220
Isle of May	57	240
Do	36	110
Bell Rock	100	90
Girdleness		185
Do		115
Buchanness	100	180
Kinnaird	57	120
Skerries		160
Tarbet	120	175
Noss Head		175
Dunnet	45	346
Pentland	30	170
Do	10	140
Start	80	100
Sumburgh	35	300
Cape Wrath	50	400
Glass	80	130
Barra Head		680
Skerryvore	Rockawash	150
Lismore	do	108
Rhins of Islay	80	150
Kyntyre	28	297
Pladda	80	180
Mull	70	325
Little Ross		175
Corsewall	92	112
Calf of Man	55	375
Do	40	282
Douglas	65	104
ENGLAND—WEST COAST.		
St. Bees	33	333
Walney	60	70

APPENDIX F—Continued.

Names.	Height of tower.	Elevation above sea level.
	<i>Feet.</i>	<i>Feet.</i>
Black Rock.....	118	118
Lesowe.....	50	300
Lynus.....	36	128
Skerries.....	54	117
Stack.....	59	201
Bardsey.....	79	129
Small's (Rock).....		70
St. Ann's.....	44	192
Do.....	17	159
South Bishop.....	36	144
Caldy.....	40	210
Mumbles.....	56	114
Nash.....	90	167
Do.....	45	122
Flatholm.....	77	156
Lundy.....	89	540
Trevoise Head.....		204
Do.....		129
IRELAND.		
Fastnet Rock.....	75	151
Cape Clear.....	42	455
Kinsale.....	42	274
Kinsale Harbor.....	35	98
Hook Tower.....	110	152
Tuskar.....	81	101
Wicklow.....	58	250
Do.....	29	121
Baily.....	42	134
Poolbeg.....	63	68
Carlingford (Rock).....	111	101
Copeland.....	52	131
Maidens.....	60	84
Do.....	60	94
Innistrahul.....	26	167
Tory Island.....	63	125
Killybeg.....	41	104
Eagle.....		220
Clare Island.....	26	349
Arran.....	37	498
Loophead.....	49	269
Kilkradan.....	26	133
Skellig.....	26	372
Do.....	26	173
NOTE.—This list comprises all the most important lights.		
BELGIUM.		
Ostend (second order fixed).....	72½	87
NETHERLANDS.		
Westkappel (fixed).....		146
Schouwen (first order lens).....		170
Goeree (fixed).....		148
Brielle (fixed).....		203

APPENDIX F—Continued.

Names.	Height of tower.	Elevation above sea level.
	<i>Feet</i>	<i>Feet.</i>
Egmond-aan-zee		125
Kykduin		154
Vlieland		151
Terschelling		177
HANOVERIAN.		
Borcum	110	142
HAMBURG.		
Neuwerk (fixed)	128	
DANISH.		
Skaw		69
Anholt		123
Hesseløe		85
Nakkêhoved		147
Kronborg		113
Thunøe		100
Stevensklint		144
Fakkebeirg		128
Hameren		280
Lubeck	113	
PRUSSIAN.		
Arcona		203
Jershöft		165
Rixhöft		226
Hela		130
Brüsterort		143
Memel		98
SWEDISH.		
Orskär		113
Grönskär		103
Korssö		151
Landsort		145
Öland		130
Kullen		283
Winga		97
Marstrand		292
NORWEGIAN.		
Færder		216
Jumfruland		134
Oxøe		140
The Naze		146
Markøe		201
Gunnarshong		129
Hoidingsøe		133
Rondøe		168
Guitholmen		131
Terningen		100
Agdenæs		116

APPENDIX F—Continued.

Names.	Height of tower.	Elevation above sea level.
	<i>Feet.</i>	<i>Feet.</i>
Villa Oen.....		124
RUSSIAN.		
Swalferort.....		110
Riga.....		100
Filsand.....		110
Do.....		96
Dagerort.....		538
Odensholm.....		111
Pakerort.....		146
Sourop.....		136
Narghen.....		115
Revel.....		135
Do.....		210
Hogland.....		382
Outö.....		145
Hangaoud.....		107
Parkaloud.....		172
Euskar.....		163
Odessa.....		203
Pellinghe.....		126
Tarkhankoot.....		115
Khersonese.....		109
Inkerman.....		420
Do.....		360
Takli.....		168
Belosaräisk.....		176

APPENDIX F—Continued.

Trinity House Corporation lights in 1834.

No.	Name.	Character of light.	Number of lamps and reflectors.
1	Scilly.....	Revolving.....	30
2	Edystone.....	Fixed.....	24
3	Portland.....	Revolving.....	21
4	Lizard.....	Fixed.. (2)..... each.	19
5	Flamborough.....	Revolving.....	21
6	South Stack.....	Revolving.....	21
7	Beachy Head.....	Revolving.....	30
8	Heligoland.....	Fixed.....	24
9	Foulness.....	Revolving.....	30
10	Longships.....	.....	19
11	N. Foreland.....	.....	18
<i>Floating lights.</i>			
1	Newarp.....	.....	24
2	Goodwin.....	.....	24
3	Galloper.....	.....	16
4	Haisborough.....	.....	16
5	Stanford.....	.....	12
6	Gall Stream.....	.....	12
7	Lynn Well.....	.....	16

Whole number of lens lights in 1834.....	None.
Whole number of Trinity House lights in 1834.....	42
Whole number of Trinity floating lights in 1834.....	13

Trinity House Corporation lights.

Total number of light-houses in 1845.....	66
Do.....do.....floating lights in 1845.....	25

Of that number there were in 1845—

1st order lens lights.....	11
2d....do....do.....	4

Total number of lens lights in 1845.....15

Of the 51 remaining (reflector) lights—

2 were fitted with 30 lamps and reflectors each.	
1 was fitted with 27....do....do....do.	
1.....do.....26....do....do....do.	
4 were fitted with 24....do....do....do.	
2.....do.....21....do....do....do.	
3.....do.....19....do....do....do.	
3.....do.....18....do....do....do.	
3.....do.....17....do....do....do.	
3.....do.....15....do....do....do.	
1.....do.....14....do....do....do.	
5.....do.....13....do....do....do.	

Of the 25 floating lights belonging to the Trinity House in 1845—

2 were fitted with 24 lamps and reflectors each.	
9.....do.....16....do....do....do.	
1.....do.....12....do....do....do.	
8.....do.....8....do....do....do.	
5.....do.....4....do....do....do.	

6 lens apparatus have been introduced into the Trinity House lights between 1846 and 1851.
The fourth order lenses are introduced as substitutes in harbors for reflectors.

APPENDIX F—Continued.

Scotch lights.

Of the 24 northern lights in 1834, the following were fitted as below:

No.	Name.	Number of lamps and reflectors.
1	Isle of May.....	24
2	Bell Rock.....	20
3	Girdleness.....	28
4	Buchanness.....	24
5	Kinnaird Head.....	18
6	Tarbetness.....	21
7 & 8	Pentland Skerries. (2)	60
9	Sumburgh Head.....	26
10	Dunnet Head.....	17
11	Cape Wrath.....	20
12	Island Glass.....	19
13	Barra Head.....	21
14	Lismore	18
15	Islay	24
16	Mull of Kintyre.....	20
17	Mull of Galloway.....	17
18	One of only.....	9
	Six of only.....	12

Of the 27 northern lights in 1845, there were—

4 dioptric lights. (Reflector lights.)

1 fitted with 28 lamps and reflectors.

2.....do....26....do.....do.

4.....do....24....do.....do.

2.....do....21....do.....do.

2.....do....20....do.....do.

1.....do....19....do.....do.

3.....do....18....do.....do.

1.....do....17....do.....do.

1.....do....16....do.....do.

4.....do....12....do.....do.

In 1851 nearly all the northern lights fitted previously with reflectors and Argand lamps had been changed to lens lights and the colza or rape-seed oil introduced.

Perfectly formed parabolic reflectors, heavily plated with silver and of large size, are employed in the lights of Great Britain, chiefly 24 and 21 inches in diameter.

Reflectors are being changed as rapidly as possible for lenses, and the Holophotal system of lenses and reflectors upon the plan of Mr. Thomas Stevenson of Edinburgh.

Of the sea-coast lights of Ireland in 1845—

1 was fitted with 40 lamps and reflectors.

1.....do.....28.....do.

1.....do.....27.....do.

2.....do.....26.....do.

2.....do.....24.....do.

2.....do.....23.....do.

6.....do.....21.....do.

2.....do.....20.....do.

3.....do.....19.....do.

1.....do.....17.....do.

2.....do.....16.....do.

3.....do.....15.....do.

Floating lights.

1 was fitted with 24 lamps and reflectors.

2 were fitted with 16.....do.

Lens lights are being introduced into Ireland, and the colza or rape-seed oil substituted for winter-strained sperm oil.

APPENDIX F—Continued.

French lights.

Name and character of light.	Height of tower.	Elevation.	Range.
	<i>Feet.</i>	<i>Feet.</i>	<i>Naut. miles.</i>
Dunkerque, 1st order, revolving.....		192	24
Gravelines, 3d order, fixed.....		94	15
Calais, 1st order, movable.....	166	189	20
Cape Grisnez, 1st order, revolving.....	47	192	22
La Canche, 1st order, fixed.....	169	172	20
Cayeux, 3d order, movable.....		91	15
Treport, 4th order, fixed.....		36	9
Fecamp 1st order, fixed.....	55	422	18
Fecamp, 4th order, revolving.....		39	9
La Heve, 1st order, fixed.....	65	393	20
Havre, 4th order, fixed.....		39	10
Taucarville, 1st order, movable.....	104	416	.....
Point de Ver, 3d order, movable.....	43	137	15
Pointe de Barfleur, 1st order, revolving.....		234	22
La Hague, 1st order, fixed.....		156	18
Isles Chansey, 3d order, movable.....	55	120	15
Granville, 3d order, fixed.....	43	153	15
Cape Frehel, 1st order, revolving.....	72	257	22
Heaux de Brehat, 1st order, fixed.....		146	18
L'Isle de Bas, 1st order, revolving.....	180	221	24
L'Isle d'Buessant, 1st order, fixed.....	84	273	18
St. Matheiu, 2d order, revolving.....	81	175	18
Portzec, 2d order, movable.....	107	182	18
L'Ile de Sein, 1st order, movable.....		135	20
Bec du Raz, 1st order, fixed.....	50	257	18
Belle Ile, 1st order, revolving.....	150	273	27
Chassiron, 1st order, fixed.....	140	163	18
Cordouan, 1st order, revolving.....	205	.....	24
Cape Bearn, 1st order, fixed.....	30	743	18
Mont d'Agde, 1st order, revolving.....	75	410	27
Mont Pestusuto, 1st order, revolving.....	52	322	27

There are, in addition to the foregoing, 1st order lights, with elevations 133 feet, range 22 miles; 192 feet, range 18 miles; 175 feet, range 18 miles; 237 feet, range 20 miles; 160 feet, range 18 miles; 134 feet, range 18 miles; 130 feet, range 20 miles; 260 feet, range 20 miles; 420 feet, range 27 miles; 335 feet, range 18 miles; 266 feet, range 22 miles; 286 feet, range 18 miles; 338 feet, range 20 miles; 215 feet, range 20 miles.

Second order lights, 78 feet elevation, range 18 miles; 104 feet, range 18 miles; 150 feet, range 18 miles.

Third order lights are given a sufficient elevation to average a range of about 15 nautical miles.

Fourth order lights (harbor lights) have generally an average range of 9 to 10 nautical miles.

This list comprises all the important lights of France.

APPENDIX F—Continued.

Table of distances at which objects can be seen at sea according to their respective elevations and the elevation of the eye of the observer.

Heights in feet.	Distances in English miles.	Distances in nauti- cal miles.	Heights in feet.	Distances in English miles.	Distances in nauti- cal miles.	Heights in feet.	Distances in English miles.	Distances in nauti- cal miles.
5	2.958	2.565	70	11.067	9.598	250	20.916	18.14
10	4.184	3.628	75	11.456	9.935	300	22.912	19.87
15	5.123	4.443	80	11.832	10.26	350	24.748	21.46
20	5.916	5.130	85	12.196	10.57	400	26.457	22.94
25	6.614	5.736	90	12.549	10.88	450	28.062	24.33
30	7.245	6.283	95	12.893	11.18	500	29.580	25.65
35	7.826	6.787	100	13.228	11.47	550	31.024	26.90
40	8.366	7.255	110	13.874	12.03	600	32.403	28.10
45	8.874	7.696	120	14.490	12.56	650	33.726	29.25
50	9.354	8.112	130	15.083	13.08	700	35.000	30.28
55	9.811	8.509	140	15.652	13.57	800	37.416	32.45
60	10.246	8.886	150	17.201	14.91	900	39.836	34.54
65	10.665	9.249	200	18.708	16.22	1,000	41.833	36.28

* “The spheroidal form of the earth requires that the height of a light-house tower should increase proportionally to the difference between the earth’s radius and the secant of the angle intercepted between the normal to the spheroid at the light-house, and the normal at the point of the light’s occultation from the view of a distant observer. The effect of atmospheric refraction, however, is too considerable to be neglected in estimating the *range* of a light, or in computing the height of a tower which is required to give to any light a given range; and we must, therefore, in accordance with the influence of this element, on the one hand, *increase* the range due to any given height and *vice versa reduce* the height required for any given range, which a simple consideration of the form of the globe would assign.”

If the distance at which a light of a given height can be seen by a person on a given level be required, it is only needful to add together the two numbers in the column of distances corresponding to those in the column of heights, which represent respectively the height of the observer’s eye and the height of the lantern above the sea. When the height required to render a light visible at a given distance is required, we must first seek for the number corresponding to the height of the observer’s eye, and deduct this from the whole proposed range of the light, and opposite the remainder, in the column of distances, seek for the corresponding number in the column of heights.

* Alan Stevenson on light-houses, p. 159, *et seq.*

APPENDIX F—Continued.

Statement showing the increase of lens lights in France since 1834.

FRENCH LIGHTS.

Character of lights.	Number.
<i>In 1834.</i>	
Lens lights.....	29
Reflector lights.....	45
Total.....	74
<i>In 1845.</i>	
1st order reflector lights.....	4
1st order lens lights.....	31
2d.....do.....do.....	4
3d.....do.....do.....	13
4th.....do.....do.....	57
Total of lens lights.....	109
Reflector lights (small).....	42
Total.....	151
<i>In 1851.</i>	
1st order lens lights.....	39
2d.....do.....do.....	5
3d.....do.....do.....	16
4th.....do.....do.....	66
Total of lens lights.....	126
Reflector beacons.....	40

The lights of Algiers and the colonies are not included in this list.

Statement showing the number of lens lights in existence in 1851.

LENS APPARATUS.

In 1845, there were lights fitted with the three first orders of lens apparatus throughout the world.....	95
Smaller catadioptric lights.....	115
Total lens lights.....	210
From 1845 to 1851 (six years) there were constructed in Paris and sold—	
1st order lens apparatus.....	65
2d.....do.....do.....	20
3d.....do.....do.....	36
4th.....do.....do.....	37
Total in six years.....	158
Total of the three first orders of lens apparatus in use in 1851.....	216
Smaller lens lights.....	152
Total of lens lights in 1851.....	368

APPENDIX G.—Nos. 1 to 6.

LETTERS RELATING TO SANKATY HEAD—SECOND ORDER LENS LIGHT.

G—No. 1.

*Letter of W. R. Easton.*CUSTOM HOUSE,
District of Nantucket, August 3, 1851.

SIR: In reply to your communication of the 15th ult., I have to say, that I have never seen the Sankaty Head light at a greater distance than 12 miles, but have watched it much from various points, and have made comparisons between it and Great Point light. The Great Point lighthouse is furnished with 15 Argand lamps, and as many 21-inch reflectors; it consumes about 600 gallons of oil annually, and has been considered one of the best lights on the coast. The lens light on Sankaty Head, has one concentric lamp with three tubes and wicks, and consumes about 380 gallons of oil annually, and for brilliancy and intensity there is no light on the American coast that will compare favorably with it, if I can rely upon the testimony of many sea-captains and others who have given their opinions upon it. From my own observations, at distances of 3 to 12 miles, I have no doubt of the correctness of the opinions above referred to. The Sankaty Head light is seen every clear night from the continent, a distance of 41 miles, and an elevation of about 30 feet above sea level. It is seen by our coasters from New York and Boston, while coming down the Vineyard sound and running along the shore of Cape Cod, at distances of 30 to 40 miles, from decks which are about six feet above sea level. One captain said to me that he had seen it frequently when off Holmes' Hole, a distance of at least 30 miles, and from its extreme brilliancy it appeared to be only five or six miles off. Those masters of coasters who have seen the flashes of Sankaty Head light when coming down the Vineyard sound, or running the Cape shore, you will perceive, have land-marks by which they are enabled to determine their distance from the light with precision.

The Sankaty Head light has never been extinguished by accident. I was present when it was first lighted, and remained three days and nights to observe the manner of cleaning and lighting. No difficulties have attended the management of this light in any respect. There was no difficulty in obtaining a competent keeper for it. The keeper was, for many years previous, a captain of a ship in the whaling service, and is a very intelligent man. The assistants were also seafaring men.

The Great Point, Cape Cod, and Boston lights, have long been decidedly the best lights in this vicinity, but the general opinion now is, that neither of them will compare favorably with the Sankaty Head light. There is no wavering or hesitancy with those persons whose business lead them to look for these lights often. When they give their opinion, they do it decidedly and at once. Some of them call the Sankaty Head light, the "Rocket light," others the "Blazing star." The fishermen say that they can see

to bait their hooks by the flashes, in the night season, and all agree that there is no light which they have ever seen, that is equal to it.

I am, very respectfully, your obedient servant,

WM. R. EASTON,
Collector.

THORNTON A. JENKINS, Esq.,
Lieut. U. S. N., and Secretary to Light-house Board, Washington, D. C.

G—No. 2.

Letter of Lewis L. Adams.

SCHOONER TYROL,
NANTUCKET, August 25, 1852.

SIR: I received a communication from you not long since, asking for whatever information I might be able to afford you, relative to the Sankaty Head light; in answer to which, I can only say that I have seen it from Cotuit Port, which is situated in the south-western part of Barnstable, upon the north side of the Vineyard sound—distance by estimation 38 miles.

The elevation from which I have been enabled to see the light, I should think to be about 50 feet. The Sankaty Head light is to be seen from that place very distinctly at all ordinary times of seeing. I should judge from its brilliancy that it could be easily discovered at least 15 miles further upon the same elevation. I think it to be a first-rate light, and in my opinion, it stands unequalled upon our lighted coast. * * * * *

The general opinion of the merits of the Sankaty Head light is, that it is far superior to any upon our coasts.

Should you have any occasion to ask for any further information, I hope I shall be prepared, and it shall be attended to with the greatest pleasure.

I am, very respectfully, your obedient servant,

LEWIS L. ADAMS.

T. A. JENKINS, Esq.

G—No. 3.

Letter from Benjamin C. Chase.

NANTUCKET, July 12, 1851.

SIR: Yours of July 15 was duly received. Agreeably to your request I will readily give what observations I have made on the lights.

Sankaty Head shows a clear, brilliant light when the flashes are at their greatest power, and may be distinctly seen (in clear weather) from the deck of a vessel of one hundred tons, twenty-five miles distant. I have seen it myself, several times, from the deck of the George Washington—height of the eye above the sea-level, twelve feet. As regards the distance and the means of obtaining it, there can be no dispute. I have seen it, when at anchor near the shore of the cape, say one mile, Chatham lights bearing west; and I have seen it when sailing along at the back of the cape, with

Chatham bearing W. by S., which would give a distance of twenty-five miles. Chatham and Sankaty bearing north and south from each other, the dip of latitude gives the distance twenty-five miles.

My business (packeting to and from Boston) gives me good opportunity to observe the lights on that route. In coming from the north, in clear weather, we raise Sankaty Head light above Great Point; the point being six or seven miles nearest. The elevations of the two towers I do not precisely know. It is my opinion that were the lights to change places, the point would be seen first coming from the north. In the route from Nantucket to Boston, the most important lights are Great Point, Highlands of Cape Cod, and Boston. Several times, when in Massachusetts bay, I have seen from the deck, Boston and Cape Cod lights at the same time, distance between them fourteen leagues; Boston light is good; Cape Cod is a little better. I have never seen the cape but it showed a good light. I have seen Boston light asleep twice, eight or nine years ago.

The Minot's ledge light, when living, was a No. 1 light; unimportant in clear weather, as Boston could be seen distinctly before getting up with the ledge, but in thick and hazy weather, it was of the greatest importance. The light-vessel on the station exhibits a paltry light. Collector Greeley advertises that a better light will be shown from her in a short time.

Monomoy, Chatham, Nausett, Race, Plymouth, Marble Head, Salem and Cape Ann lights are good No. 2.

Very respectfully, your obedient servant,

BENJ. C. CHASE,

THORNTON A. JENKINS, Esq.,
Secretary of Light-House Board.

G—No. 4.

Letter from Charles H. Coleman—Light-boat keeper.

NANTUCKET, August 11, 1851.

SIR: Yours of July 15, asking for whatever information I may be able to give respecting the lights in this vicinity, and particularly the Sankaty Head light, has been received.

In reply, I would mention the means we have of comparing, from the Cross Rip station, the two systems.

We generally see four fixed lights with reflectors, viz: West Chop light, WNW., eighteen miles distant; Cape Poge, W $\frac{3}{4}$ S., nine miles; Point Gammon, N. 16° E., twelve miles; and Great Point (on what is frequently called sandy point of Nantucket) bearing S. 72° E., sixteen miles distant; all of which are perhaps of equal or greater importance to the coasting trade than the Sankaty Head light. The Great Point light is, I think, of as much importance as any light on the coast, and I believe is thought to be as good as any of the same number of burners and reflectors. When the air is in a state to bring the Great Point light just in sight above the horizon, we are not able to see the Sankaty Head light without an elevation of three and a half or four feet. When seen, it is far superior in strength and brilliancy to the Great Point light. I mention the circumstance of the first appearance of the two lights, merely to show that if the

two lights were equal, the Great Point light would be seen first by vessels approaching them from the westward, through the Vineyard sound, whereas, I am told by the masters of vessels that pass through the sound, that they must invariably see the Sankaty Head light first.

As respects the distance that Sankaty Head light has been seen, I have seen it several times from Cape Poge, a distance of thirty-two miles, from a position of twelve feet above the sea level.

I have been told by several masters of coasting vessels, that they have seen it three or four miles to the westward of Cape Poge, and that they generally raise it before they do the Great Point light; it has been seen frequently from Chatham bar and that vicinity, a distance of thirty to thirty-five miles from the decks of coasting schooners, the distance calculated by the difference of latitude and longitude. I have no doubt that it can be seen forty-five miles, from a ship's deck, when the weather is favorable.

I have never heard of the Sankaty Head light being out when it should have been lighted.

I have never heard of any difficulty attending the management of the Sankaty Head light.

As regards the obtaining of competent keepers, I don't know that there was any difficulty about it. There were two keepers appointed before it was lighted; what the cause of the second appointment was, I don't know.

Alexander D. Bunker, the present keeper of the light, was master of a whaling ship from this port several voyages, and was considered one of the most competent masters from this place.

I believe it to be the general opinion of the seafaring community, that it is decidedly the best light on the coast.

I am, very respectfully, your obedient servant,

CHAS. H. COLEMAN,

Keeper of the floating light, Cross Rip, Tuckernuck shoal.

THORNTON A. JENKINS, Esq.,

Lieut. U. S. N., Sec'y. to Light-House Board.

G—No. 5.

Bodkin point or Seven-feet knoll light-house, mouth of the Patapsco, Chesapeake bay

OFFICE LIGHT-HOUSE BOARD,

October 10, 1851.

SIR: I have the honor to submit, herewith, plans, drawings, and specifications, for a light-house on "Seven-feet knoll," in the Patapsco river, which have been carefully prepared by the Committee on Construction of Light-houses, and examined and approved by the board.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,

President Light-house Board.

HON. THOMAS CORWIN,

Secretary of the Treasury.

WASHINGTON CITY, October 10, 1850.

SIR: The committee to whom was referred the resolution of the board of July 26th, respecting a screw-pile light-house for "Seven-foot knoll," at the mouth of the Patapsco river, respectfully report the drawings herewith, marked A, B and C, containing the plans, sections and elevation of a structure for that locality, as also a description of the same, marked D.

JOS. G. TOTTEN,

Brevet Brig. Gen'l and Col. of Engineers.

JAMES KEARNEY,

Lieut. Colonel Topographical Engineers.

Report on the Seven-foot Knoll light-house.

The committee to whom was referred the subject of the proposed light-house on the Seven-foot knoll, off Bodkin point, mouth of the Patapsco, respectfully report the following considerations:

That a screw-pile light-house, on the same principle as that erected at the Brandywine shoal, be adopted for the position in question.

That an estimate, with drawings, be prepared accordingly, to be submitted for the consideration of the board, and being by them amended, if necessary, be submitted for the sanction of the Secretary of the Treasury.

That on the plans and estimates thus sanctioned, proposals be called for in the public newspapers, for the erection, under contract, of the light-house and ice-breaker.

That in the acceptance of any such proposals by the Treasury Department, the execution of the work be put under the immediate and constant supervision of some competent engineer.

That the height of the light-house above high water mark should be forty feet.

That the light should be of the third order of French lenses, whether fixed or revolving to be determined hereafter.

Respectfully submitted.

JOS. G. TOTTEN,

Brevet Brig. Gen'l and Col. of Engineers.

JAMES KEARNEY,

Lieut. Colonel Topographical Engineers.

Adopted.

TREASURY DEPARTMENT,
October 13, 1851.

SIR: I transmit, herewith, the plan and specifications, by J. W. P. Lewis, for a light-house at the Seven-foot knoll, Patapsco river, which the party offers to construct for the amount of the appropriation.

The party presenting this plan states that it shall be, in all respects, similar to the one recommended by the light-house board, and executed agreeably thereto, except that it has a broader foundation, has not the

third story, and the two actual stories are of wood, on an iron frame-work, instead of being entirely of iron, as in the plan submitted by the board.

As the season is rapidly passing, the department would be pleased to have the opinion of your board upon the above modifications, provided that, in all other respects, the plan already submitted by the board should be carried into effect.

Very respectfully, your obedient servant,

THO. CORWIN,

Secretary of the Treasury.

Com. W. B. SHUBRICK,

President Light-house Board, Washington.

REPORT.

OFFICE LIGHT-HOUSE BOARD,

October 13, 1851.

The committee to whom was referred the letter of the assistant Secretary of the Treasury of this date, (October 13,) submitting to the board Mr. Lewis' plan, sections, and specifications of a light-house for the entrance of the Patapsco, have given them the hasty examination which the time allowed would permit, and have, respectfully, to report:

That they do not now see any irremediable defect in that plan which contemplates a wooden superstructure, and do not, therefore, object to it as a temporary work; but seeing that the Bodkin light is to be suppressed on the completion of the Seven-foot Knoll light—and therefore the work is to be viewed not merely as a local accommodation to the bay craft and coasters, but as the principal guide to the foreign shipping of the port of Baltimore—we cannot recommend it, believing that, in a position of so much importance, only a permanent light will fulfil the essential conditions.

Respectfully submitted.

JOS. G. TOTTEN,

Brevet Brigadier General and Colonel of Engineers.

JAMES KEARNEY,

Lieutenant Colonel Topographical Engineers.

Adopted.

OFFICE LIGHT-HOUSE BOARD,

October 13, 1851.

SIR: I submit, herewith, an estimate for the screw-pile light-house, recommended by this board for the "Seven-foot Knoll," which is intended to accompany the plans and drawings submitted with my letter of the 10th instant.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,

President Light-house Board.

Hon. THOMAS CORWIN,

Secretary of the Treasury.

Estimate of the cost of a screw-pile light-house on the plan proposed to the Light-House Board by the committee to whom the subject was referred by the order of July 26, 1851, including the cost of a lantern and lenticular apparatus of the 3d order of Fresnel for the "Seven-foot Knoll," at the mouth of the Patapsco.

Foundation screws, including patentees charges.....	\$1,082 70
Foundation piles	2,575 80
Extension tubes.....	1,678 00
Couplings	1,041 39
Girts, gibs and keys.....	616 80
Girders and ties.....	2,571 75
Braces and tie bolts	72 00
Turn-buckles	96 00
Floor plates	2,931 12
Railing and cantilevers.....	591 80
Keeper's house, watch-room, stairs, ladders, tanks, partitions, cranes, casing, &c.....	6,000 00
Total for iron.....	19,257 36
Machine work, fitting and erecting structure.....	13,000 00
Fresnel light, 3d order, with eclipses, apparatus and lantern complete	5,000 00
Contingencies.....	2,742 65
Total estimates	40,000 00

Description of a screw-pile light-house proposed for the "Seven-foot Knoll," at the mouth of the Patapsco river.

Sheet A, fig. 1. Vertical section through the centre of light-house, (east and west.) The piles are nine in number of solid malleable iron o o o in three rows. The eight outside piles forming a square, whose o o o side is 32 feet from centre to centre of the corner piles. These o o o piles have screws similar to those used at the Ice Harbor on Brandywine shoal. The piles are $8\frac{1}{2}$ inches in diameter, fit into the lower tubes a little above low water, and are fastened to them by nut and screw-bolts running through corresponding flanges on file and tube couplings, (see vertical sections, fig. 2, sheet A.)

Four sets (nine in each set) of hollow tubes of cast-iron rise above each other from the main frame or skeleton of the light-house, and carry it to the height of 53' 9" above low water. The outside tubes of the lower set will be about 16' 6" long. They are perpendicular to the water to within about a foot of their upper ends, at which point they bend in order to assume the inclined direction required by the pyramidal form of the light-house. The centre tube is of course perpendicular to the water in this set of tubes, as well as in all the other sets.

The manner in which the tubes are connected together, so as to form continuous lengths, is shown in vertical section, fig. 3, (sheet A.) At each point where two tubes meet, there are two coupling tubes which cover the joint, and which are fastened together by nut and screw-bolts. It will be perceived, on examining the drawings, that whilst, by the nature of the joint, a perfectly close and immovable junction is effected, the coupling tubes can at any time be slipped off on removing the bolts which confine them, and the main tubes thus be set at liberty. So that, if required, the

tube or any part of the framing of the light-house, may be easily taken out and repaired, without affecting in any great degree, the other parts of the structure. There are also flanges on the main tubes, to prevent sliding in the vertical plane.

On the lower end of the two coupling tubes with which each joint is provided, will be cast brackets for supporting cast-iron main-girders, running horizontally between the tubes. Of these main girders there will be

12 at 16 feet above low-water.

12 at 28.7 do do

12 at 41.2 do do

12 at 53.9 do do., at the top of the system of tubes,

—

being 48 main girders in all.

Fig. 4, (sheet A,) gives the plan and elevation of a portion of one of these girders, etc. Brackets cast on some of the lowermost of the outside tubes will support cantilevers, (see fig. 3, sheet A,) on which to rest the balconies. There will be

12 of these cantilevers for lower balcony.

12 do do upper balcony.

12 do do lantern balcony.

—

36 of these cantilevers in all.

In addition to the above girders there will be

16 transverse girders at the height of 16 feet above low-water,

12 do do 28.7 do

8 do do 4.12 do

4 do do. at the top of tubes.

—

40 transverse girders in all.

Along the main outside girders, at intervals of about three feet, brackets will be cast to support additional cantilevers for the balconies. These cantilevers will be as follows :

32 for lower balcony.

24 for upper balcony.

12 for lantern balcony.

—

68 in all.

To resume, the total length of main tubing will be about 492 feet. These tubes will be about 11 inches in outside diameter at bottom of light-house, diminishing to about $9\frac{1}{2}$ inches at the top, with a thickness of $1\frac{1}{2}$ inches at bottom, diminishing to about 1 inch at top.

The total length of coupling tubes will be about 126 feet,

The total length of girders 967 feet, viz :

12 of 14.6 = 174.

16 of 15.9 = 252.

12 of 11.9 = 141.

12 of 12.3 = 147.

12 of 8.3 = 99.

8 of 9.0 = 72.

12 of 5.0 = 60.

4 of 5.6 = 22.

967 feet in all.

The total length of cantilevers will be about 364 feet, viz :

24 of 3.8 =	88.
12 of 2.0 =	24.
56 of 4.0 =	224.
12 of 2.4 =	28.
	364 feet.

On the coupling tubes will also be cast the necessary pins, loops, &c., for attaching the various ties or braces. Of these tie-rods or braces there will be four tiers, corresponding to the spaces between low-water and first set of girders.

1st and 2d sets of girders.

2d and 3d " "

3d and 4th " "

The 1st tier of tie-rods, consist of—

24 vertical,	21 =	504.
16 horizontal,	16 =	456.
16 " "	21 =	336.
2d tier, 8 vertical,	16 =	128.
8 " "	19 =	152.
8 horizontal,	13 =	104.
8 " "	17 =	136.
3d tier, 8 vertical,	14 =	112.
8 " "	16 =	128.
8 horizontal,	9.6 =	76.
8 " "	11 =	88.
4th tier, 12 vertical,	14 =	168.
12 " "	13 =	156.
8 horizontal,	6 =	48.

Total length of tie-rods will be about - - 2,392

Fig. 5 (sheet A) shows the manner in which the horizontal and diagonal braces are attached to the coupling tubes, and in which the main girders and cantilevers fit into the brackets, and are confined by keys or wedges.

Fig. 6 (sheet A) is a section parallel to axis of tube of that part of a bracket (on coupling tube) which embraces the end of a girder.

Fig. 7 (sheet A) is the vertical section of the top of one of the uppermost tubes, with its coupling tube or cap; and fig. 8 (sheet A) is a horizontal section of the said cap.

It will be seen that the frame for sustaining the lantern is fixed to the cap and tube by a strong screw. In fig. 9 (sheet B) which is a plan of the girders, caps, &c., at top of tubes, the plan of the frame for sustaining the lantern is shown. This frame bears on the top of all the nine caps, and thus has nine points of support at which it is secured firmly down to them. It rests also on the girders.

The stem or vertical axis of the lighting apparatus might be inserted into the cap and centre tube, and thus obtain a solid base to revolve upon.

In fig. 9 (sheet B) is also shown the plan of the lantern base, resting on the supporting frame and secured to it.

Fig. 10 (sheet A) is a vertical section showing the lantern base of hollow cast-iron, connected with the frame for sustaining it.

In figure 9 (sheet B) a dotted line shows the position and size of the "man hole" for reaching the lantern from the watch-room. The circular dotted line at centre of plan, is to show the extent to which the lower part of the machinery of the lighting apparatus will protrude round the centre or vertical axis.

It is proposed to enclose the structure within a sheathing of corrugated iron at a distance outside of the tube of 1' 3" from their centres. This will extend from the platform on which the lantern rests down to the lower range of girders or sixteen feet above low-water.

An inner sheathing of the same material also 1' 3" distance from the centre of tubes, and parallel to the outer sheathing (2' 6" distance from it) forms the walls of the apartment alluded to in the general section, figure 1, (sheet A,) and in the plans 11, 12, and 13, (sheet B.) In fig. 3, and fig. 7, (sheet A,) is shown the manner in which it is proposed to attach this sheathing to the frame-work of the light-house above and below the girders, &c.

Fig. 14 (sheet A) is a vertical section of an outside girder, also showing the manner in which the transverse girders and cantilevers are attached to it.

It is proposed to have cast-iron frames to receive the window sashes. These will be upright, as shown in fig. 15, 16, 17, (sheet B.) The door frames will also be of cast-iron, but will not be required to be upright. It would be desirable that they should be so, but the vertical tie-rods would then interfere with the doors, which they will not do when the doors and frames are inclined, as shown in fig. 18 and 19, (sheet B.)

Fig. 20 (sheet B) is a plan exhibiting the arrangement of the lowermost range of girders and cantilevers, on which the lower floor is sustained. The outside and inner horizontal tie-rods are also shown. The inner tie-rods have turnbuckles, but these are not required on the outer tie-rods, as they are provided at their ends with screws and nuts for tightening them. The vertical tie-rods throughout the structure are also intended to have turnbuckles.

Figs. 21 and 22 (sheet B) show the arrangement of the girders under the upper floors.

Figs. 11, 12, 13, are plans of the several floors into which the light-house is subdivided (below the lantern) and the arrangement and dimensions of the rooms, closets, &c., in each.

A spiral stairway (of wrought-iron) starts from the lower floor, winds round the centre tube, and reaches the watch-room floor, whence it is thought that a ladder will be all that is required to reach the lantern through the "man hole."

Sheet C contains an elevation of the south side of the light-house.

G—No. 6.

Flynn's Knoll, New York Harbor, &c., &c.

OFFICE LIGHT-HOUSE BOARD,

January 15, 1851.

SIR: I am directed by this board to communicate to the department the result of their investigations in relation to the erection of a light-house on Flynn's knoll, in New York bay, agreeably to your instructions.

The board, in a communication to the department in July last, stated that they had great doubts as to the propriety of commencing this structure ; since that time they have collected additional information, by which they have been enabled to arrive at the following conclusions :

1. That there is no necessity for erecting a light-house on Flynn's knoll, in New York bay.

2. That to do so would involve the risk of serious injury to the channels and bars.

3. That by a judicious system of range lights, all the facilities necessary for ingress and egress of vessels, navigating by day or by night, would be afforded.

The board therefore respectfully recommend that authority be asked of Congress to apply the appropriation for Flynn's knoll light-house to the erection of four small range-lights, two of them to be placed on or near the line L M, and two on or near the line F S, as designated on the coast survey chart of New York bay, to serve for the main channel around southwest spit, and through the swash channel to the eastward of Flynn's knoll.

The board further recommend an appropriation for a bell buoy to be placed on or near Flynn's knoll.

The board not having the means at their command for making the necessary surveys of the sites for these proposed range lights, are indebted to Professor Bache, superintendent of the coast survey, for all the detailed information on this part of the subject, and concur with him in recommending that beacons be located on or as near these points designed on the chart, as may be found to be practicable.

The board recommend that should Congress authorize these range lights to be erected, a competent engineer officer be detailed for erecting the structures, to be furnished by the superintendent of the coast survey with such surveys as may be required.

In the opinion of the board, one Third, and three Fourth order lenses will be required for these light-house towers, which should have a sufficient elevation to give the requisite ranges of twelve to nine miles.

In connection with this subject, they consider it their duty to call the attention of the department to the subject of buoys, in this and other principal bays and harbors, with reference especially to the law of 1850, on the subject of coloring and marking buoys.

The channel into New York bay, discovered and surveyed by the officers of the coast survey, and known as "Gedney's channel," requires to be better marked than at present, to enable pilots and others to avail themselves of the greater depth of water.

All of which is very respectfully submitted.

WM. BRANFORD SHUBRICK.

President Light-house Board

Hon. THOMAS CORWIN,

Secretary of the Treasury.

Report of Flynn's Knoll Lighthouse.

OFFICE LIGHT-HOUSE BOARD,

October 9, 1851.

The committee to whom was referred the subject of a light-house on Flynn's knoll, after visiting that locality, and carefully considering all the information on the subject collected by the board, are of opinion:

That the placing of a light-house of any kind on Flynn's knoll is a matter of so much importance, in view of the effect that it may have on the channel, and the necessity for a light there at all as an aid to navigation, has given rise to so much diversity of opinion among pilots, insurance companies, and others interested in commerce, that they cannot now advise any structure to be placed on the knoll, but recommend a large bell-buoy or floating beacon to be placed at such point as will best serve to indicate the position of the shoal.

The committee make this recommendation, because they are unwilling to advise any step which experience may prove not to be the most judicious; and further examinations may afford safer grounds than they at present possess for coming to a decision.

Respectfully submitted.

JOS. G. TOTTEN,

Brevet Brig. General, and Col. of Engineers.

JAMES KEARNEY,

Lieut. Col. Topographical Engineers.

Adopted.

OFFICE LIGHT-HOUSE BOARD,

Washington City, June 13, 1851.

SIR: The light-house board, in compliance with the request contained in your letter of the 28th ultimo, proceeded to New York, and on the 3d instant visited the locality indicated by previous surveys for a light-house on Flynn's knoll.

The importance of affording to the commerce of New York every facility of ingress and egress—the great hazard to which valuable property, and still more valuable lives might be exposed, if any means should be neglected which would enable the mariner to find, with the greatest possible certainty, the wished-for haven—caused the board to approach the subject of this light-house, with an anxiety to make just and proper conclusions which it need not express.

Information which might assist the board in its judgment, was sought for from all reliable sources within its reach. Some it has obtained; of more it is yet in expectation. With such aids, with its personal examination, and with the excellent coast survey chart of the harbor before it, the board feels no hesitation in expressing the following opinions:

1. That the necessity for a light-house on Flynn's knoll is, to say the least, not so urgent as to require immediate action under the law of March 3, 1851.

2. That it is probable that the advantages to be expected from a light-house on Flynn's knoll may be in a measure obtained by ranging lights on the New Jersey and Staten Island shores, not to exceed four in number.

3. That even if it should be found that a light on Flynn's knoll is neces-

sary, the question as to the kind of structure most proper for that position is one, the decision of which requires more information than the board has yet been able to obtain.

Independent of all considerations of expense, the erection of a stone structure (always the best when the position will admit of it) would involve hazards to the channel by interrupting the natural course of the waters, the consequences of which cannot be foreseen, and which greatly outweigh any benefits that could possibly be expected from the light.

Two other modes of obtaining foundations for light-houses on sand-shoals have come under the notice of the board—one by means of solid screw-piles, worked into the sand by mechanical power; and the other by means of hollow cylinders of hard metal, driven deep into the sand by the pressure of the atmosphere, and filled either with masonry or concrete. It has been stated, in an examination had before a committee of the House of Commons, in 1850, that a cylinder was sunk sixty-five feet by this process, in the Goodwin sands.

This method, which is of recent invention, claims to possess advantages over the others that are worthy of attention; but the board desire to have time to make further inquiries in relation to it.

The patentee of this invention for the United States has a contract for the construction of a wharf at Cape May, in an exposed situation, and has informed the board that he should be at work there, he thought, by the 15th of July next. This will afford an opportunity to witness the process in operation, of which it is the desire of the board to avail itself.

On the 10th instant the board visited the Bodkin shoal, (seven-foot knoll,) on the subject of which a special report will be made after the examination of the Brandywine shoal light, which is on screw-piles, and the operation of the pneumatic pile wharf at Cape May.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,

President Light-house Board.

Hon. THOMAS CORWIN,

Secretary of the Treasury.

COAST-SURVEY OFFICE,

November 29, 1851.

SIR: An examination made of Flynn's knoll, New York harbor, with the members of the light-house board, induced a doubt in my mind whether the light-house proposed to be erected there was the best aid to navigation which could be suggested, and, indeed, whether it might not alter, injuriously, the present régime of the harbor. The inquiries of the light-house board were directed to the same points, and their conclusions will, therefore, also be before the department.

It occurred to me that a system of range-beacons could be used for passing Sandy Hook by the main ship-channel, and for passing through the swash channel, which would answer all the purpose of the proposed light on Flynn's knoll, without being attended with any risk of causing new deposits on the bar, and which could be put up and maintained at a very small expense. I have accordingly caused minute surveys to be made of the shore near the probable sites of these beacons, and transmit, herewith,

the sketches and report returned by Assistant J. B. Glück, of the coast survey; and also a coast survey chart of New York bay and harbor, marking these and other sites on which range-lights may be established to answer the purpose referred to above.

I would recommend two range-lights, (beacon,) to lead from the point G, in Gedney's channel, through the main ship-channel to the range of the beacons already recommended in the sailing line H N, through the narrows; the beacons to be on the line G B, or G M, or in the angle between them, as may be found most expedient on an examination, which should be made just previous to their location. The distance A D is rather small for the range, being less than one-ninth of G A. A beacon near L will furnish, also, important ranges.

Also two leading lights, (beacon lights for the swash channel,) nearly on the line S E. Before placing these lights, the swash channel should be carefully re-surveyed; which can be done at a very trifling expense by the coast survey, by using existing marks on the shore already determined in the survey, as there is an impression among the pilots that it is deepening. The beacons should be placed accordingly.

These lights should be so arranged that they will appear nearly in one, when heading on the sailing lines. They should be distant from each other not less than about one mile and a half, or one-sixth of the distance from which they are first required to give the range. They should be carefully screened, so as only to show a light on the range or ranges which they are to indicate; and for distinction from each other, as they are only required to show some nine miles, the one near the Elm-tree beacon may be a red light, (deep red.)

Yours respectfully,

A. D. BACHE,

Superintendent United States Coast Survey.

Hon. THOMAS CORWIN,

Secretary of the Treasury.

Extracts from a report on ranges in New York bay, to the superintendent, by J. B. Glück, esq., assistant in coast survey.

UNITED STATES REVENUE CUTTER TANEY,

Brooklyn, N. Y., July 15, 1851.

DEAR SIR: I have just returned from surveying the two ranges for entering swash and main channels, of New York bay, in accordance with your instructions of July 1st.

The range for entering Swash channel, of which Elm Tree beacon forms one point, affords unusual facilities, as it strikes over the narrow brows of three elevations of one and a half, ($1\frac{1}{2}$), one and three quarters, ($1\frac{3}{4}$), and two miles distance from the beacon; being respectively sixty, (60,) eighty, and one hundred and sixty feet (160) high. That of sixty is bare; that of eighty is covered with trees and thick brushwood from twenty to twenty-five feet high; and the one of one hundred and sixty, with forest trees from sixty to seventy-five feet high. These sites are upon the estate of Mr. George Ebbitt, New Dorp, Staten Island.

The range for coming through main ship-channel, touches the shore nearly

a mile eastward of Point Comfort, through a very depressed part of the beach; the sand banks on either side (from ten to twelve feet high) sinking nearly to the level of high-water mark. About three hundred metres back from the beach, the range strikes a swamp thickly covered with trees from fifteen to forty feet high: thence it runs mostly through woodlands, occasionally through settlements and clearings. About a mile inland from the beach the range crosses the creek and marsh, making in to the westward of Point Comfort. Upon the whole line surveyed there is no point that reaches an elevation of twenty-five feet, and, as I am informed, there is none for five miles further back, to the hills near Middletown. From the terminus of my survey I could see back nearly another mile, but no higher elevation on that extension could be gained; I therefore confined the survey to the limits formed by the creek, on the banks of which the hills are slightly the highest. On this range both lights could be screened by trees so as to be invisible to seaward, except on the range itself.

I am much indebted to Captain Rudolph, commanding United States revenue schooner Taney, and his officers, for their kindness in aiding the survey, and extending every facility possible to its accomplishment.

* * * * *

I herewith send the maps of New York bay, upon which I have marked the two ranges as directed.

The front light on Point Comfort range for coming through the main channel, might be placed at either A or B. The light would probably be sufficiently screened at A, from being seen at sea, by the clump of trees about one hundred metres to the southeast, or by the woods at Sandy Hook, until the vessel is on the range itself. At B this purpose would be fully achieved.

The back light on this range might be properly placed at either C or D. The ground at D is several feet higher than at C, and therefore preferable. But little cutting is required to clear this whole range.

On the range for entering through Swash channel, where Elm Tree beacon now stands, will be the place for the front light. The breakwater should be moved to the westward of the beacon instead of to the eastward, as this structure, in its present position, only serves to undermine the beacon, for the protection of which it was built. Complaints are made in regard to the color, which is red. At a distance of about two miles off shore, I found it to be scarcely visible.

There are four points on this range where the beach light might be located, although C is, in my opinion, the most desirable site for it being on an elevation of eighty feet, covered with trees and bushes high enough to screen the light from either side. The sites A and B are bare, and respectively twenty and sixty feet high.

That at D, is from one hundred and forty to one hundred and sixty feet high; the thick and almost inaccessible forest makes it difficult to give a true delineation of the ground or an accurate valuation of its elevation.

A black and white flag is fastened to the highest tree on the range, and the tree determined. Trusting that I have executed this work to your satisfaction,

I am, most respectfully, your obedient servant,

JOHN B. GLÜCK,

Assistant in Coast Survey.

Professor A. D. BACHE, LL. D.,

Supt. U. S. Coast Survey, Mount Pleasant, Maine.

TREASURY DEPARTMENT,
May 28, 1851.

SIR: By the act of 3d March last, thirty thousand dollars are appropriated for a light-house on Flynn's Knoll, near Sandy Hook, N. Y., and seventeen thousand dollars, in addition to a previous appropriation, for a light-house on the Bodkin shoal, (otherwise called Seven-foot knoll,) mouth of Patapsco river, Maryland.

Desiring to avail myself of the professional knowledge and experience of the light-house board, as to the proper kind of structure to be placed at these several points, I have to request that the localities thus indicated may be visited and examined by the board, or by at least two of its members, with a view to that object, and that the opinion of the board, found from such examination, may be reported to the department with an estimate of the cost of the structures so recommended.

The revenue cutters employed on the Norfolk and New York stations, or the steamers on coast survey duty, may be used in the performance of this service, as may be found most convenient.

Very respectfully, your obedient servant,

THOMAS CORWIN,
Secretary of the Treasury.

Commodore WM. BRANFORD SHUBRICK,
President of the Light-house Board, Washington.

TREASURY DEPARTMENT,
May 29, 1851.

SIR: I transmit you, herewith, a copy of a letter addressed to the Collector of New York, requesting him to furnish all the information in his power to any members of the light-house board respecting the light-houses connected with that harbor, and to place the revenue cutter at their disposal, for visiting the different points which they may desire.

In case circumstances shall not admit of the cutter being employed on the above service, you are authorized to employ some other suitable vessel or steamboat for the purpose, on reasonable terms.

Very respectfully, your obedient servant,

THOMAS CORWIN,
Secretary of the Treasury.

Commodore W. B. SHUBRICK, *Washington.*

OFFICE OF LIGHT-HOUSE BOARD,
Washington city, June 11, 1851.

SIR: I am directed by the light-house board to ask of you the favor to communicate, at your earliest convenience, any information which may be at your command, in relation to improvements in lights and other aids to navigation in the vicinity of New York bay, and the approaches to it.

The board would respectfully call attention to the following points:

Is there any necessity for a light-house on Flynn's knoll?

Would a system of ranges on the Jersey and Staten island shores obviate the necessity for placing a light-house on Flynn's knoll?

Have vessels, and how many, been wrecked and suffered for want of a light on Flynn's knoll, within a specified number of years?

Have vessels been prevented from running in for want of a light on Flynn's knoll?

What particular advantage is to be gained by placing a light on Flynn's knoll?

What is the condition of the buoys and dumb beacons?

Are the buoys of proper dimensions, shape, and color?

Are there a sufficient number of buoys and dumb beacons?

Is the light-vessel near Sandy Hook properly placed, and if not, what position is proposed?

What reasons for wishing the position of the boat retained or changed?

As the board is anxious to make a report, which it cannot do until it is in possession of all the reliable information upon the subject which it can obtain, it requests as early a reply to this communication as may be practicable.

I am, sir, very respectfully, your obedient servant,

THORNTON A. JENKINS,

Lieutenant U. S. Navy, Secretary to Light-House Board.

To the PRESIDENT

Of the Board of Pilots and others, New York.

NEW YORK, *June* 14, 1851.

SIR: Your favor of the 11th came to hand, and in answer to the inquiries relating to the light-boats, beacons, &c., in the vicinity of New York bay and the approaches to it, I will endeavor to state my views as far as my knowledge and experience goes.

In the first place, you ask is there any necessity for a light-house on Flynn's knoll?

I think not. Ranges on Jersey and Staten island would answer much better.

In the second place, you ask how many vessels have been wrecked and suffered for want of a light there, and how many have been prevented from running in for want of a light there within a number of years.

I am not aware of any. Vessels do frequently get on there in thick weather in day time; very seldom in night time, for in clear weather there are plenty of ranges night or day to be seen, with a good pilot on board, to keep vessels from getting on there. Large vessels seldom come in at night, unless the weather is clear.

In the third place, you ask what particular advantage is to be gained by placing a light there?

I think it far better as it is, without any light on the knoll; as the lights on Sandy Hook are so very near the knoll, they would appear as very near together a little distance off. A dumb beacon put there would answer, I think, far better than a light.

In the fourth place, you ask what is the condition of the buoys and dumb beacons, and are the buoys of proper shape and color?

The dumb beacon, I think, is of a proper size and color. The buoys are small—color very well as they are.

In the fifth place you ask, is the light-boat off the Hook properly placed; if not, what position is proposed?

The boat cannot be put in a better position than where she now is. Should she be taken from there, many vessels would be lost in the neighborhood of Sandy Hook; whereas now, when they make the light-boat, they can shape their course for the Hook, let the weather be ever so thick, and get in safe. But was no boat there, and thick weather, and a vessel getting close in and nothing of the Hook to be seen, and the wind from south-east, she could not possibly haul off, but would go ashore. In 1847, I was coming home from Cadiz, in the ship *Thomas Dickinson*, it was blowing heavy and very thick; we made the light-boat and found our way in; but had there been no light-boat there, we could not possibly have got off clear. The vessel must have gone ashore unless cables and anchors had held her.

In the sixth place, you ask what reasons for having the boat's position retained or changed?

I cannot see any reasons for removing the boat from her present position.

Respectfully, your obedient servant,

ELBERT LATHAM,
Captain.

THORNTON A. JENKINS, Esq.,

Lieutenant U. S. Navy and Secretary to Light-House Board.

OFFICE OF THE BOARD OF UNDERWRITERS,
New York, June 14, 1851.

SIR: Yours of the 11th is received. I shall be obliged to obtain part of the information you desire from practical men engaged in passing in and out of Sandy Hook.

I now send you a communication signed by about twenty ship-masters, requesting that the light-ship may be kept in her present situation, and that she may be furnished with a gun.

I will furnish you with additional matter as it comes in my possession, which may take some time to procure.

Very respectfully, your obedient servant,
WALTER R. JONES, *President.*

To Lieut. THORNTON A. JENKINS,

Secretary of the Light-house Board.

PORT WARDEN'S OFFICE,
New York, June 17, 1851.

SIR: In compliance with the directions of the light-house board, asking for any information which may be at my command, in relation to improvements in lights and other aids to navigation, in the vicinity of New York and the approaches to it, I herewith send you my answers to the following questions, viz:

Is there any necessity for a light-house on Flynn's knoll? In reply I would say, no.

Would a system of ranges on the Jersey and Staten Island shores obviate the necessity for placing a light-house on Flynn's knoll? A system of

ranges on Jersey and Staten Island shores would be far more beneficial to the navigation than a light on Flynn's knoll.

Have vessels, and how many, been wrecked and suffered for want of a light on Flynn's knoll, within a specific number of years? I have only known some two or three vessels to have been wrecked on this shoal since 1818.

Have vessels been prevented from running in for want of a light on Flynn's knoll? I should say not, so far as relates to vessels having pilots on board.

What particular advantage is to be gained by placing a light on Flynn's knoll? A light on Flynn's knoll would designate, of a clear night, the starboard or north side of the channel to vessels bound in, but in hazy weather it would be liable to be confounded with the Hook lights.

What is the condition of the buoys and dumb-beacons? The buoys generally are in pretty good floating condition, and the dumb-beacon on Romer shoal is a solid and substantial structure.

Are the buoys of proper dimensions, shape, and color? A cone placed on the head of the present can-buoys would make them much more conspicuous, for in rolling they would be more likely to attract the eye. The color of the buoys has too much sameness to be depended upon in rough weather by vessels passing quickly through the water, particularly in hazy weather.

Is there a sufficient number of buoys and dumb-beacons at present? There is a sufficient complement of buoys when the usual number is laid down. I would not hesitate to say, that if a dumb-beacon was placed on Romer shoal, on the south-east part, and also one on Flynn's knoll, near the edge of their respective channels, they would be important as guides in coming in, or going to sea.

Is the light-vessel near Sandy Hook properly placed, and if not, what position is proposed? In my judgment, I say that the light-vessel is properly placed for large-class ships and steamers.

What reasons for wishing the position of the boat retained, or changed? My reasons for the ship's retaining her present position are, that she has proved to be an important guide in taking a departure from her to run for the bar. She is also useful to the largest class ships, to lay by her during the night, while waiting for an opportunity to run in. She is particularly serviceable to pilots, in aiding them as a mark to steer from, to run in for the bar. The only good reasons that I can give for a change would be in exchanging the vessel itself for a new one, as she is getting old. A new light-ship of greater length, and with all the modern improvements in model, lights, &c., would add much to the safety of commerce to and from this port; and in conclusion, I would strongly urge the present light-ship station to be retained.

I am, with great respect, your obedient servant,
ROBERT T. NORRIS.

THORNTON A. JENKINS,

Lieut. U. S. Navy, Sec'y to Light-house Board.

NEW YORK, June 30, 1851.

SIR: I have received your note of inquiry respecting the light-houses, buoys, beacons and light-boats within the vicinity of Sandy Hook and New York bay.

Without repeating here all the questions you ask me on the separate heads, and wishing to be as brief as possible in the premises, I will take them up in their order.

There is *no* necessity for a light on Flynn's knoll. I am too well satisfied from long practical observation, that a light-house on that spot would be an injury rather than a benefit.

I think that if a light-house and beacon were placed on the Jersey shore, somewhere in the vicinity of Point Comfort, that they would be sure guides into the Hook, and serve also as marks, both by day and night, for Flynn's knoll; and I think also, when properly understood, after a short practice by pilots, (proper) can be made a leading mark for the *western* entrance of Gedney's channel.

This channel, which has some peculiar advantages over the other two channels over the bar, is sadly in want of leading marks for its best water. A light-house or monument of sufficient height, should be built somewhere in the vicinity of Princess bay light, on the Staten Island shore, so as to make a leading mark for its ESE. and WNW. courses.

In consequence of a want of proper marks, and having little faith in the buoys remaining in their proper places, I am too well satisfied that there is more water in Gedney's channel (going around the bar) than there is over the bar, in either the old north or south channel. But, I ask, where is the use of a good channel, if there are not proper and permanent marks established for it? This is all that is wanted to make it understood, and to give security to the heaviest vessels (either war or merchant) known to us, (at a proper time.) The buoys in Gedney's channel are but poor affairs at the best; they do not show to much advantage. They should be topped three feet higher, and not so sharp at the foot of the buoy; and then, if they would float higher out of the water, would be of some real use to those who, like myself, have confidence in them, and who wish to establish for the port of New York that name which she is entitled to, as being first among the States of the Union.

You ask what is the condition of the buoys and the dumb beacons? The dumb beacon on Romer is in very good condition, as far as the structure is concerned, but it should be painted white, and then it could be seen further, particularly in the night, when it is much sought after by coasters, pilots, and all others navigating that bay.

As regards the buoys in the lower bay, I unhesitatingly say (and such also is the opinion of all ship masters, coasters, pilots and others navigating that bay whom I have spoken to on that subject,) that they are miserable in the extreme, and have been so for many years; but they are now worse than ever they were before. The buoys that were formerly black, are now red. These red* buoys cannot be distinguished in their color, even in the day time, without you are near enough to touch them; and at night it is utterly out of the question to tell whether it is a red or a black buoy you have made.

Much indeed might be said on this subject, as regards the size and colors

* The red paint being bad, is the cause of this.

of these buoys for day or night, and in thick weather; but I will only remark here, that if a pilot cannot see his land-marks, he cannot tell what buoy it is he sees; and when his marks can be seen, the buoys are (to pilots) of but little consequence.

I have always understood that buoys have been intended for thick or hazy weather, when land-marks cannot be seen accurately, and also for the use of those who do not know the private marks or ranges for the shoals which they are placed upon. If a buoy is made suddenly, in coming out of a fog, which is often the case, the colors are so nearly alike, even at short distances, that it is next to impossible to tell its color.

The buoys on the tail of the west bank, upper middle, western knolls, S. W. spit, and the buoys on the bar, should all be made at least one-third larger; as they now stand, in color and size, they are mere apologies for buoys, as far as pointing out a shoal goes.

I would seriously recommend that a large bell-buoy should be placed on Flynn's knoll, until those ranges can be built on the western shore, as a mark for the knoll and for the western entrance of Gedney's channel. There is a large spar-buoy placed on that shoal at this time; it is painted white, and it can be seen further than any other buoy in the bay. This is entirely owing to its strongly contrasting color on the water. This is the standard opinion among all pilots that I have conversed with, and also of all others who have seen it and compared it with the red buoys.

As regards the lights and beacons in and about the bay of Sandy Hook, as regards their strength, they may be termed from fair to middling; I have seen far better. The light lately erected on Sankaty Head, Nantucket, is by far the best light that I have ever seen in my cruising off and on our coasts. I see no reason why the lights on Sandy Hook cannot be made as good as that; and, sir, if a little more attention was paid to keeping the east beacon from *going out* as often as it does, and generally just before daylight, it would give greater satisfaction, and more security to all those who have to navigate that bay and the approaches to it. I hear many complaints from pilots on this subject. I do not wish to censure these light-house keepers; but if the fault lies in the lighting apparatus, it should be remedied as early as possible. This is saying the least I can of it, and the best too.

There should also be built a light-house and beacon on Staten Island, on the ground known to pilots and others as the "four sand hills," for running through the swash channel in the night time, and particularly to steamers of light or moderate draught of water. These lights are much needed. There has been little or nothing done for commerce and navigation in the bay of New York and Sandy Hook, in the way of light-houses or permanent marks. Pilots and others have been mainly indebted to nature and accidental causes for their marks for shoals and channels.

There is a very prominent mark standing on Staten Island, and known to pilots as the "old mud fort." This mark is highly useful in crossing the bar. From the improvements that are every day taking place, I am very well assured that it will share the fate of many others of like value, and a useful mark will be lost, for the best water over the bar, in the old south channel, and for the outer middle.

It is full time that this subject should be fully and clearly looked into. The general government should appoint some of our best naval officers to this post, and a separate bureau should be placed under their control,

having no connection with any other department. Then, and not until then, will we have a proper and well regulated system of lights and buoys on our whole coast.

In relation to the light-boat off Sandy Hook, I unhesitatingly say, without any fear of successful contradiction, that she is in every respect properly placed, and could not be moored in any other spot, outside or inside of Sandy Hook, where she could give so much use and security to all vessels coming in and out of this port and the approaches to it.

The strength and height of her light could, I think, be improved. There should be another (a spare light-ship) always ready to take her place in case of any accident to her, or when she is obliged to come into port for repairs, &c. Her place should never be left unprovided. I trust that your best efforts will be used to call the earliest attention of Congress to a general revision of this whole department, and to the placing of some naval officer of known ability at the head of it.

I have the honor to be, very truly, yours,

JOHN MAGINN,

President N. Y. Pilot Association.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to Light-house board.

NEW YORK, *August 4, 1851.*

DEAR SIR: At the request of Walter R. Jones, esq., president of the board of underwriters of New York, I hereby give you my views relative to lights, buoys and beacons, for the south coast of Florida and the harbor of New York. I have had experience as a ship-master, twenty years, and the past seven years I have been employed as underwriters' agent. I have given much attention to this subject. I was pleased to learn that government had resolved to protect the interests of commerce, by selecting competent and scientific gentlemen to look after this important work.

As regards lights, &c., you ask, is it necessary to build a light-house on Flynn's knoll? I answer distinctly, no. A light-ship or a large buoy of a tripod form, would mark the danger, and my reason for not building a light-house, is the danger of affecting the channel. This shoal may increase, and it may decrease; and it will strike the mind of a careful observer, that it is dangerous to alter the natural current. The depth of water is now about sufficient for our ships of war and merchant ships—twenty-three feet at low water is the most that can be found on the bar. As regards the buoys of this harbor, some of them are small, and more attention ought to be paid to them, especially in the winter time, when the floating ice often removes them. Our merchant and steamships are increasing in size and numbers, and the importance of this harbor is felt by every State in the Union.

You ask, is the light now moored off Sandy Hook useful to commerce? I answer yes, and ought not to be removed. I have, in my own experience, known the advantage of this light-ship, in foggy weather; also in the winter time, when snow storms occur. It is a good departure for the bar. The light ship bears nearly ESE. six miles from the bar buoy, and about E. by S. eight miles from Sandy Hook light-house. A large bell on board, to ring in thick weather, and a signal gun, would be very beneficial to navigators. I believe this light-ship has been the protection of life, and much

property has been saved since she was stationed there. I have resided the past six years at Key West, Florida, and have given particular attention to the subject in view of that coast. The light-house on Garden Key, Tortugas, is now a very good light, and is kept in perfect order; in clear weather it can be seen eighteen miles from aloft. A beacon should be placed on Sand Key shoal, near Loggerhead Key, one of the most western keys. This bad shoal, on which many vessels have been lost, lies about WSW. five miles from the light-house. A beacon on Bird Key shoal, about SSW. three miles from the light-house, would be of service. A beacon on a shoal about NE. by N., six miles from the light-house should be erected; also a beacon on Rebecca shoal, about twelve miles to the eastward of Garden Key light-house. The light-house now in progress on Sand Key, to replace the one destroyed by the hurricane of October 12, 1846, will be of great importance; eight vessels, and the value \$425,000, have been ashore near this spot the past sixteen months. The light on Key West is a very good light, and kept in perfect order; but when Fort Taylor is finished, it would best serve the interests of commerce to have it removed to the fort. The light-ship in the northwest passage is well kept, but the light is not brilliant. As the coasting trade is soon to be done by steamships, this passage will be very important. A few beacons could be easily erected near the bar, as I learn from Captain John Rogers, that he has found more water through this passage than the pilots know of. This gentleman has also found more water in over the reef than has been known before, and I refer you to him to give the location for buoys and beacons required to enter the harbor of Key West from the Gulf. A beacon on the eastern Sambos, and on the American shoal, (all in sight of Key West,) and on the edge of deep-water, is much required. A beacon to replace the one destroyed in 1846, on Looe Key, is very much wanted. One on Alligator shoal, and Sombrero, with one on the Fowey rock, near Cape Florida light-house.

The light-ship on Carysfort reef has been lately put in fine order, and the light very much improved. The light-house now building on Carysfort reef is a magnificent work, and this light can be seen when lighted 25 miles, and by day it will be a good mark for a departure. I trust it has strength to resist the violence of hurricanes, (as all light-houses should be built with this in view.) The light at Cape Florida is very good, and well kept. The beacons on the several shoals, that I have alluded to, should be made of iron screw-piles; it is true, salt-water in time will destroy them, but the cost is trifling, and the beacons could all be erected in a short time, and pay the expense by the use the coast survey will make of them.

The expenses of coast survey come from the national treasury, and the benefit arising from these beacons will lessen their expenses, and give great facility to this important work of giving to navigators a correct chart of the most dangerous parts of our coast.

The known ability of the gentlemen composing your board is a sufficient guarantee to all persons interested, that government will act promptly in such improvements as you may recommend.

Very respectfully, your obedient servant,

JNO. C. HOYT.

T. A. JENKINS, Esq.,

Secretary Light-House Board, Washington City.

The beacon on Rebecca shoal should be about thirty-five feet high.

The beacon on Loggerhead Key shoal should be about twenty-five feet high.

The beacon on Bird Key and other shoals about twenty feet high.

The form and heads of these beacons could be so arranged as to be seen a long distance, and to be of different forms.

Memorandum.

OFFICE ATLANTIC TRUST INSURANCE COMPANY,
New York, September 19, 1851.

I think the light-ship is in the right place, and that it is of immense importance to the commerce of New York that she should be kept there. Her lights could probably be very much improved, and she could be furnished with a much larger bell; both of which would add very much to her efficiency, if they could be kept in order and used at the proper time. The lights in the harbor are, as far as I know, all very well; but I think the entrance to our harbor could be made much safer, and very much more convenient, by erecting a good light on the eastern part of "Romer shoal." Relative to buoys, I think the system, as at present existing, is about as good as any that could be devised, if said system could be promptly executed. They had, as I understand it, two sets of buoys; one for ice time, which are simple spars, painted different colors, and anchored on end; the other set are can-buoys, of good size, and likewise painted different colors. These buoys should be shifted at the proper time, and much attention paid to keeping them in their proper places. I likewise think that Fire Island light could be much improved, by being made higher and adopting the French reflectors.

SAML. J. WARING, *Inspector.*

CHAMBER OF COMMERCE,
New York, November 8, 1851.

SIR: I have the honor to enclose, herewith, the report of a committee of this chamber, upon certain matters submitted to it by the light-house board at Washington.

Will you be good enough to place the report before that board, and to say that the chamber approved of it, and directed me to send them a copy of it.

With much respect, I have the honor to be, sir, your most obedient servant,

M. MAURY, *Secretary.*

To the Hon. the SECRETARY OF THE TREASURY,
Washington City

TREASURY DEPARTMENT,
November 10, 1851.

SIR: I transmit, herewith, a letter from the Chamber of Commerce a New York, with its enclosure, which is in reply to a communication from the Light-house Board.

Very respectfully, your obedient servant,

THO. CORWIN,
Secretary of the Treasury.

Com. W. B. SHUBRICK,
President Light-house Board, Washington.

The committee appointed by the Chamber of Commerce to report upon a communication made by the light-house board to the Chamber, relative to improvement in lights, &c., to the navigation of New York bay, do report:

That they do not think it advisable to go far into the question of the quality of our lights on the sea-coast as all the testimony is in favor of the general superiority of French and English lights, over those of our country; although we have recently much improved the efficiency of ours, still much remains to be done. The committee will therefore confine themselves to such additions and alterations as are in their judgment necessary to make this harbor accessible as it should be by night or day, which is not the case at present.

The additions necessary to the safe navigation of this port are—

The speedy completion of the beacon on the southeast point of Romer, and the lights on the west end of Long Island near Fort Hamilton, intended as a mark for the main-ship channel at night; both the above are already appropriated for by Congress. A light-house is necessary on Flynn's knoll, that steamers and vessels of heavy draught of water may come in at night, which now is a matter of great danger on account of the narrowness of the channel; and they are obliged to either anchor or lie too outside. For this thirty thousand dollars has been appropriated, and this committee are informed that persons are ready to construct one for the above sum, and it is to be hoped that no more delay will take place in its construction.

A beacon of a small size is also wanted on the shoal ground off the west bank.

The light-house at Fire island should have more illuminating power, and a light of moderate brilliancy of a distinct character from that of Fire island or Montauk point should be placed midway between them, as a sea-mark, the south side of Long Island being difficult to recognise between those two points, a distance of sixty-seven miles.

The buoys of our harbors are, as far as we can hear, in good order, and now well attended to, the former practice of taking the can-buoys up too early and putting them down too late, having been on representation of its impropriety abandoned.

The lights on the highlands of Navesink (Fresnel's) are equal to any lights of the same class elsewhere, and of their general management, we hear no complaint; the same may be said of our harbor lights generally.

CHAS. H. MARSHALL,
GEO. W. BLUNT,
STEPHEN JOHNSON.

NEW YORK, November 1, 1851.

I certify the above to be a true copy of the report which was approved and adopted by the Chamber of Commerce at their meeting on 4th instant.

M. MAURY,

Secretary of the Chamber of Commerce.

NEW YORK, November 7, 1851.

Extract from the report of Captains Brewster and Dutton, and Major Smith, United States engineers, for revising the plan for a light-house on Flynn's knoll, near Sandy Hook, New York harbor.

The attention of the undersigned was first called to the position the light-house was to occupy on the shoal. The department, in its instructions, says: "It is believed that the position of the light-house has been well determined by a board of naval officers, and no deviation at all material from this position can be allowed." The board of naval officers referred to in a communication addressed to the commissioners of the navy, under date of the 26th May, 1837, describes Flynn's knoll as one of the several shoal spots, composed of fine dark sand, extending along the water-edge of a bank which forms the northern boundary of the ship-channel into Raritan bay, at the eastern end of this knoll, and eight hundred feet from the channel. We have placed a buoy to mark the most eligible position for the location of the light-house. The buoy is in twelve feet at low water, and bears from Sandy Hook light-house, according to Gedney's chart, N. 13° W. The breadth of the channel directly between the Knoll and the Hook, embracing a depth of not less than twenty-seven feet, is shown by the same authority to be 2,560 feet by this passage. All vessels are obliged to enter and depart, whose draught will not permit them to pass through the Swash channel.

The board of naval officers further states: "The object of a light-house on Flynn's knoll would be to mark distinctly the boundary of the main channel to the north; and in conjunction with the principal light-house on Sandy Hook, it would be of great service to vessels crossing the bar, either by day or night, and an unerring landmark for strangers desirous of seeking safe anchorages in the bay. It would answer also as an additional guide for entering the Swash channel."

It is also said: "Since the erection of the light-house on Sandy Hook, which was first lighted, according to the best information we have been able to collect, about eighty years ago, the point has encroached very considerably upon the sea, and particularly in a northerly direction, from which the light-house is now distant from low water-mark on the north point 4,550 feet, and is consequently of less advantage to vessels running into the bay at night; because in thick or hazy weather they cannot correctly calculate the distance from the light to the fair way, and in apprehension of running upon the Hook, a disaster by no means unfrequent, they sometimes keep too far to the north, and fall upon Flynn's knoll. To obviate the difficulty arising from the remoteness of the light-house from the channel, beacons which are lighted at night have been placed at the north and northwest points of the Hook; but so rapidly has the beach made out to the

north, that it was found expedient to advance the eastern beacon, about six years since, several hundred feet, and again it has become necessary to move it forward at least six or seven hundred feet further.

The foregoing facts in relation to the constant extension of Sandy Hook in a northerly direction are important as regards the stability of Flynn's knoll. As the volume of water passing Sandy Hook is about the same in any given period of time, the encroachment of this point on the sea would seem to indicate that the main channel is gradually increasing in depth, or that the southern side of Flynn's knoll, opposite this point, is wearing away. It was this consideration, as well as the very exposed position selected by the board of navy officers for the site of the light-house, that induced the suggestion to two of the members of the naval board, at an informal meeting held at the city of New York, of the expediency of locating the light-house further to the westward on the knoll, at the position marked B, on the sketch of Gedney's chart herewith. This position, besides placing the house on a broad part of the shoal, would have been protected from heavy southeast gales by the northern extremity of the Hook; at the same time, it would probably have been beyond the influence of any abiding action to which a greater proximity to the northern point of the Hook might be liable.

The position, however, chosen by the board of naval officers involved important considerations in respect to the main and swash channels, which rendered any material change in the site of the light-house inadmissible. It was at the same time stated that two buoys had been placed on the knoll, about — yards apart, designating the extreme east and west limits between which sites might be selected for the house. The choice of position was therefore confined to very narrow limits, it being necessary, on the one hand, to avoid that occupied by the preparatory works of Major Smith, marked S, on the sketch, which had been selected near the western buoys; and on the other hand, it seemed desirable to leave as much space between the eastern extremity of the knoll and the light-house as possible. The position chosen is marked E, on the sketch, and is further indicated by a circle drawn to the same scale with the chart, the circumference of which circle is the exterior boundary of the permanent breakwater surrounding the house when completed.

It will be perceived by inspection of the chart, that this is the broadest part of the east extremity of the shoal; the surface for a considerable space being nearly level, and at a depth of fourteen feet below the plane of low water. The bearing of the centre of this position from the light-house on Sandy Hook, is N. $17^{\circ} 30'$ W., distant 8,823 feet; from the northern point of the Hook the distance is 4,918 feet; from the eastern extremity of the knoll 1,262 feet; from the northern edge of the knoll, opposite the point, 398 feet; from the southern edge of the knoll, opposite the point, 60 feet; from the centre of the position selected by Major Smith, 365 feet; and from the buoy (marked N on the sketch) placed by the board of naval officers as mentioned in their communication to the commissioners of the navy, 717 feet. With regard to the altitude of the light, the board of naval officers in the same communication referred to, suggest that it be of the same height from high water mark as that on Sandy Hook. Captain Kearney, one of the members of this board, in a subsequent communication to the Secretary of the Navy, in answer to certain interrogations propound-

ed by the Secretary of War relative to the light-house proposed for Flynn's knoll, says "that it should not be less than eighty feet from the level of the sea to the lantern of Flynn's knoll light;" and for reasons more at large, I beg to refer you to a report I made, in connection with Captains Sloat and Perry, to the board of navy commissioners. This officer further states: "Inasmuch as the light at Flynn's knoll is the most important, other lights in its vicinity should be accordingly, not only differing distinctly in color, but also in their height. The Flynn's knoll being the highest and most conspicuous, would guard against any mistake that otherwise might occur, especially in fogs, when only at certain times the top of the light-house can be discerned. This error of mistaking Sandy Hook light for Flynn's knoll light-house in a foggy day, and steering accordingly, might prove fatal. It is not an improbable thing that such would be the case, was there not a greater distinction in the height of these lights; therefore, to produce the greatest difference possible, I would recommend the following alterations to be made. Premising the light on Flynn's knoll to be eighty feet high, I would reduce the present light-house on the Hook, so that including the elevation of the land or sand hill on which it stands, it should be no more than fifty feet above the level of the sea. This would give it still a considerable elevation over the beacons, and preserve its usefulness as a leading mark for pilots, for which it is only serviceable now after they get into port and bound up the bay."

Captain Sloat, another member of the board of navy officers, in a letter to the Secretary of War under date of December 18, 1838, in answer to the question, "What is the least height for the light on the knoll, that will answer the purpose of navigation?" says, "in my opinion, not less than sixty feet above high water mark to the base of the lantern." I did not preserve a copy of the report made to the commissioners of the navy on the subject, but I believe that the height fixed upon by the board, after well considering the subject, was eighty feet. The light on Sandy Hook is about one hundred. It was thought advisable that it should be nearly the same, to enable the navigator to judge more correctly his distance from each. The point opposite the knoll is very dangerous, and the water is very deep to the beach, so that the lead cannot be trusted.

In accordance with the general views of the board of navy officers, the exterior edge of the balcony of the lantern has been fixed at eighty feet above the level of high water, making the altitude of the centre of the light above the same plane, about ninety feet.

Extract from Major Smith's report on Flynn's knoll light-house, Ex. Doc. No. 2, 3d session 25th Congress, October 20, 1838.

"The examination of the bottom at Flynn's knoll, which was completed on the 18th ultimo, showed that the sand was coarser, more compact, and less intermixed with mud at the surface and near it than it was lower down. The examination was carried to the depth of 27 feet below the surface of the sand, with the aid of an air-pipe of eight inches interior diameter, which gradually settled as the sand was excavated from within, by means of a cylindrical bucket with a valve at the bottom. Every bucket full raised,

except the first, which contained the surface crust, indicated the dissemination of mud through the sand, though not to such a degree as to authorize the impression that a stratum exclusively of mud had in any instance been passed through. Nor was the appearance different from what is usual in the formation of shoals of sand in positions contiguous to a mud bottom, such as that in the vicinity of Flynn's knoll is represented to be."

PORT WARDEN'S OFFICE,
New York, June 17, 1851.

SIR: In compliance with the directions of the light-house board, asking for any information which may be at my command in relation to improvements in lights and other aids to navigation in the vicinity of New York and the approaches to it, I herewith send you my answers to the following questions, viz:

Is there any necessity for a light-house on Flynn's knoll? In reply, I would say no.

Would a system of ranges on the Jersey and Staten Island shores obviate the necessity for placing a light on Flynn's knoll? A system of ranges on the Jersey and Staten Island shores would be far more beneficial to the navigation, than a light on Flynn's knoll.

Have vessels—and how many—been wrecked, and suffered, for want of a light on Flynn's knoll, within a specified number of years? I have only known some two or three vessels to have been wrecked on this shoal since 1818.

Have vessels been prevented from running in for want of a light on Flynn's knoll? I should say not, so far as relates to vessels having pilots on board.

What particular advantage is to be gained by placing a light on Flynn's knoll? A light on Flynn's knoll would designate, of a clear night, the starboard or north side of the channel, to vessels bound in; but, in hazy weather, it would be liable to be confounded with the Hook lights.

What is the condition of the buoys and dumb-beacons? The buoys, generally, are in pretty good floating condition, and the dumb-beacon, Romer shoal, is a solid and substantial structure.

Are the buoys of proper dimensions, shape, and color? A cone placed on the head of the present can-buoys would make them much more conspicuous; for in rolling, they would be more likely to attract the eye. The color of the buoys has too much sameness to be depended upon in rough weather by vessels passing quickly through the water—particularly in hazy weather.

Is there a sufficient number of buoys and dumb-beacons at present? There is a sufficient compliment of buoys when the usual number is laid down. I would not hesitate to say, that, if a dumb-beacon were placed on Romer shoal—on the southeast part—and also one on Flynn's knoll, near the edge of their respective channels, they would be important as guides in coming in or going to sea.

Is the light-vessel near Sandy Hook properly placed; and if not, what position is proposed? In my judgment, I say that the light-vessel is properly placed for large class ships and steamers.

What reasons for wishing the position of the boat retained or changed? My reasons for the ship retaining her present position are, that she has proved to be an important guide, in taking a departure from her to run for the bar. She is also useful to the largest class ships—to lay by her during the night, while waiting for an opportunity to run in. She is particularly serviceable to pilots in aiding them as a mark to steer from, to run in for the bar. The only good reasons that I can give for a change would be, in exchanging the vessel itself for a new one, as she is getting old. A new light-ship of greater length, and with all the modern improvements in model, lights, &c., would add much to the safety of commerce, to and from this port. And, in conclusion, I would strongly urge the present light-ship station to be retained.

I am, with great respect, your obedient servant,

ROBERT T. NORRIS.

THORNTON A. JENKINS,

Lieutenant U. S. Navy, Secretary to Light-house Board.

APPENDIX G.

TREASURY DEPARTMENT,

August 15, 1851.

SIR: I forward, herewith, a proposition from Isaac Smith, esq., to erect a light-house on Horseshoe reef, near Buffalo, New York, for the consideration of the light-house board, and should be pleased to have as early a report on the subject as practicable with their views; for if the plan is to be adopted, it will be desirable to have it under way with as little delay as possible.

Very respectfully, your obedient servant,

WM. L. HODGE,

Acting Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,

President Light-house Board.

OFFICE LIGHT-HOUSE BOARD,

August 21, 1851.

SIR: I enclose, herewith, the report of the committee of this board, to which was referred the project of Mr. Isaac Smith, for a light-house on Horseshoe reef, in the Niagara river, which report has been adopted by this board.

Very respectfully, your obedient servant,

WM. BRANFORD SHUBRICK,

President Light-house Board.

Hon. WM. L. HODGE,

Acting Secretary of the Treasury.

Report on the Horse-shoe reef light-house, Niagara river.

The committee to whom was referred Mr. Isaac Smith's plan, report as follows:

The ideas and propositions contained in Mr. Isaac Smith's communication, referred to the light-house board by the Treasury Department, on the 15th instant, have been maturely considered.

There is much in this project that is novel, as the board believes, and much that seems to be ingenious. The board must, of course, judge of it as presented them, they having no right to interpolate changes or modifications; and although the letter and the sketch presented by Mr. Smith, and explanations given personally by him, exhibit, in general terms, his intention plainly, they do not meet, much less remove, doubts which the board cannot, after much reflection, but entertain as to practical difficulties and cost of execution. The project is vague or not full, or, at any rate, not satisfactory to the board, as to the means of overcoming important practical difficulties; it relies for essential matters on untried, if not doubtful expedients; it does not contain estimates, calculated in detail, of the cost of executing the several parts, especially those deemed to be most difficult.

The committee must add that, with their understanding of the exposure of the site for which Mr. Smith's light-house was intended, they are very doubtful whether it will of itself be sufficient to resist the force of the ice that, under certain circumstances, might press against it; and if an ice-breaker be indispensable to its security, their doubts are the greater as to its title to preference over projects founded on well-known principles and processes. Accordingly, the committee does not feel warranted in advising its adoption by the government, either as a general project or for any particular site.

JOS. G. TOTTON,
Brevet Brig. Gen'l and Col. of Engineers.
JAMES KEARNEY,
Lieut. Colonel Topographical Engineers.

Adopted.

WASHINGTON, August 15, 1851.

SIR: I propose to construct for the government a foundation and light-house, with a keeper's house, on the Horseshoe reef, near Buffalo, in the following manner:

I excavate a round hole in the rock, six feet in diameter and twelve feet deep, below the surface of the rock, which is seven feet below the surface of the water.

I then construct a shaft forty-two feet in length, twenty feet of which is cylindrical, and twenty-two feet conical; the outside of the whole is a casing of boiler iron, half an inch thick, with the large end closed like the head of a steam-boiler; the whole put together in the usual manner of making heavy steam boilers; the inside of this casing (except a central circle six inches diameter) is filled with bars of two inch square wrought-iron, each bar serrated on two sides, and so placed as to leave space enough between them sufficiently wide to permit melted zinc to flow freely, and fill every vacancy. The cylinder section of the casing is to be placed with its closed

end down, in the excavation in the rock; there to be secured by long iron wedges in a perpendicular position; the entire space between the cylinder and the rock to be filled with angular stones, iron wedges, and hydraulic cement. Every bar is to reach from the bottom of the cylinder upwards to where it will reach the conical casing; at that point it is to be tapered so as to conform to the taper of the shaft. Nine of those bars (the upper ends of which do not come in contact with the casing,) reach eight feet above the top of it.

When completed, the casing, bars of iron and zinc, will form a solid metallic shaft.

On the top of the casing is a heavy cast-iron head, from which radiate, horizontally, eight wrought-iron bars, each ten feet long, which form the frame for the floor of the keeper's room and outside walk. On the highest point of the perpendicular bars, there is to be another cast-iron head, with radii, or arms, forming the frame of the upper part of the keeper's room. Under the frame of the floor there is to be eight braces connecting the outer ends of the arms with the main shaft, ten feet below the floor.

The keeper's room to be circular, fourteen feet in diameter, and eight feet high, made of boiler iron, three-sixteenths of an inch thick and lined with two or three thicknesses of sheathing felt, (non-conductor of heat,) to have a door two feet wide, five feet high, four windows, each of four panes 8 by 10 glass, the windows to be secured with iron shutters on the outside.

On the top of the upper frame I place the iron rafters of the roof, to be secured to the frame and attached to a central circular hoop five feet in diameter; from the hoop eight posts, three feet high, are to form the frame work of the lantern.

The lantern is to contain — pains of best quality glass, — by — inches, stained red; it is also to contain six lamps on one stand, without lens or reflectors; above the lanterns is to be a smoke-pipe, revolving with a vein. The roofing of the keeper's house and lantern to be of copper, thirty-two ounces to a superficial foot; outside the keeper's room, a railing four feet high extending around it. Projecting from the floor frames, are to be eight boat davits equidistant, so as to hoist the boat to such place as may be deemed expedient. Around the shaft, to be a movable frame for stairs, reaching from the water to the keeper's house, or instead of stairs, a movable jointed ladder, reaching down from the floor, at an easy angle to the rock under water.

As every part of the superstructure is subject to variation to suit the views of the department, I have not made detailed specifications.

As I ask no advance money, nor payments faster than portions of the work shall have been satisfactorily completed, I abstain from troubling you with a detail of the various processes. The main object to which I wish to call attention, is the mode of constructing the shaft, and securing it so as to resist the force of every moving object that can possibly come in contact with it. I hand herewith a drawing, which exhibits a section of a shaft and its position in a well or hole in the rock. The figure B shows the relative position of the square bars, forming a circular row on the bottom of the cylinder. As the season for action is rapidly passing, permit me to solicit a decision of the question as early as it can possibly be had.

I am, very respectfully, yours,

ISAAC S. SMITH.

To the Hon. THOMAS CORWIN,
Secretary of the Treasury, Washington, D. C.

APPENDIX H—No. 1.

PARIS, *July 29, 1851.*

SIR: The letter which you have done me the honor to address to me under date of 27th of May last, only reached me on the 5th instant, and unfortunately at the very moment of my departure for London, so that I was compelled to defer replying to it until my return to Paris.

I still belong to our light-house commission, but simply as a member, having a deliberative voice. I obtained, some five years since, permission to retire from active service in consequence of declining health, and was replaced in the double capacity of secretary to the commission and inspector of light-houses, by my fellow-laborer of long standing, Mr. L. Reynaud, engineer-in-chief, professor of architecture in the Polytechnic school, and in the school of bridges and roads. (Ponts et Chaussées.)

Consequently your letter should have been addressed to Mr. Reynaud, and you had better place yourself in relations with him, for all information concerning our light-houses; information which he is now more able to furnish than myself.

I have, therefore, thought it best to return to the legation of the United States the documents transmitted through it from yourself, with a request that they may be addressed to our minister of public works. This high functionary, I am well assured, will most cordially call the attention of Mr. Reynaud to the wishes of the American commission; and you may rely with certainty that this learned and skillful engineer will co-operate zealously in promoting the success of the important vocation which has been entrusted to you.

Nevertheless, in order to fulfil, so far as I can, the expectations of the eminent persons composing your light-house board, and to obviate as much as possible the consequences of an unavoidable delay, which I regret not being able to prevent, I will endeavor to answer immediately some of the questions you have addressed to me.

I have just read over the minutes of *two notes* which I had the honor to transmit to you under the dates of 31st of December, 1845, and 13th of January, 1846; and I can but re-assert the declarations and observations contained therein.

Theoretically considered, the relative merits of the two systems of illuminating—catoptric and dioptric—seem to me to have long since been clearly established.

In a *practical* point of view, the question does not, under all circumstances, present itself in so simple a form. There are, I am aware, certain localities, which, in consequence of the difficulty of communicating with them, together with their distances from work-shops, would cause some hesitation in confiding to keepers the charge of mechanical apparatus, when so isolated from the means of repairing those accidental injuries, which might derange the whole service of seacoast illumination.

Nevertheless, it is to be observed:

1. Wherever there is no hesitation in using the *revolving apparatus*, there should be none in the application of mechanical lamps; particularly with the precaution of having always two or three spare ones.

2. After all, the difficulty in such cases resolves itself almost in every instance into a question of expense, which is a minor consideration where an important light-house is in question. In fact, in order to secure every

precaution, it may be sufficient to secure for the chief keeper a mechanic, provided with a small number of tools and other necessities, who will himself repair any accident which may happen, but which in reality very rarely occurs.

3. In short, communication by steam in the United States is now so wonderfully developed, that no point in its immense coast can well be considered as isolated.

As regards the feasibility of converting a catoptric light in full operation into a dioptric one, it is a question for special consideration, requiring in its solution a very searching examination into local circumstances, and into the means of supplying a temporary illumination during the progress of transformation. If it be determined to erect a new tower near the old one, of course all difficulties are removed. The operation becomes a more delicate one if the new apparatus is to replace the old one in the same edifice. Nevertheless, a similar operation has been very successfully effected in our light-houses of Cordouan, Ushant, du Tour, and Havre (2;) also in the English light-houses of Inchkeith island, the isle of May, south Foreland, Eddystone, &c., &c.

In France we have not only substituted almost entirely the catoptric apparatus of our old light-houses and beacons by the dioptric one, but we purpose in a short time to renew two or three of our oldest lenticular apparatus, not that they have in any manner deteriorated, but because their plan of construction has been so much improved upon by the skill of our artisans of the present day.

On the 1st of January of this year, the illumination of the coasts of France and her colonies comprised one hundred and ninety-eight lights, large and small, out of which one hundred and thirty-two had the lenticular apparatus; thirty-one of which were of first order, six of the second, eighteen of the third, and seventy-three of the fourth. The increase since the 31st of December, 1845, has been, in lenticular apparatus twenty-one, of which four were of the first order, three of the second, and fourteen of the fourth.

Our seacoast illumination being about completed, at all events for the coasts of France and Corsica, will receive little or no modifications, so far as the lights of the three first orders are concerned. As to the small movable beacon-lights, fixed upon scaffolding at the entrance of several of our harbors, they continue to be lighted by small reflectors.

I have not the documents necessary to enable me to reply to your questions concerning the *foreign lenticular lights*. I only know their numbers to be already considerable, and that fresh orders have reached our artisans from Denmark, Sweden, England, Spain and Italy.

Some lenticular apparatus have been made in England by Mr. Cookson, of Newcastle, who soon renounced a manufacture which he doubtless found of but little profit. Two lenticular apparatus of the first order, one English, the other French, are now displayed at the great exhibition in London. So far as the cutting of the glass is concerned, I conceive them to be of equal merit; but in whiteness, the Birmingham glass cannot stand a comparison with that of St. Gobain. As to what relates to the organization of the light house service, the most important modification, since my retirement, appears to me to have been the applying to our whole seacoast the system of administration which we had previously tested for several years on the coast of the English channel. By this measure all the light-

keepers have been placed under the exclusive direction of the engineers, so that we shall have no longer the struggle against the parsimonious tendencies of the contractors.

I subjoin, herewith, two documents, drawn up and published by Mr. L. Reynaud in 1848, to wit:

1. New directions for the keeping of lenticular lights.
2. A schedule of charges for the furnishing of oil for the illumination of our coasts.

I shall close, here, my reply, which may cover, satisfactorily, the principal points in the series of questions you have presented. More ample information will doubtless be forwarded to you by Mr. Reynaud, especially upon the improvements introduced into the construction of lenticular apparatus, with their lamps, upon the present cost of these apparatus, and upon the number sent from Paris to foreign countries.

You may also consult with advantage two works published by Mr. A. Stevenson:

1. Account of Skerryvore light-house, in folio: Edingburgh, Adam and Charles Black—1848.
2. Rudimentary treatise on light-houses, in 12mo.: London, John Weale, High Holborn—1850.

While regretting that my present position has not enabled me to be more full and satisfactory, I can but congratulate myself, sir, upon the occasion afforded me of recalling myself to your kind recollection, and renewing the assurances of the high esteem of your devoted servant,

LOR. FRESNEL,

*Divisionary inspector of bridges and roads,
and member of the light-house commission.*

No. 52 Rue de Lille, à Paris.

H—No. 2.

LIGHT-HOUSE COMMISSION,
Paris, July 23, 1851.

SIR: I have the honor herewith to address you a note in reply to the questions contained in your letter of 27th May last, which only reached me on the 7th of the present month. I send you at the same time a collection of documents (printed) relating to the light-house service, also some specimens of wicks and glass chimneys, such as are now in use.

I regret that the business with which I am overwhelmed, on the eve of a tour of inspection involving an absence from Paris of three months, will not allow me to enter more into detail in my answers; but I know that my very honorable predecessor, Mr. Fresnel, has already supplied you with documents on this subject, and that your enlightened and perspicuous mind will well admit of conciseness.

You will find me, however, very ready to reply to all calls upon our experience, which you may do me the honor to address to me.

Be pleased, sir, to accept the expression of my high consideration,

L. REYNAUD,

*Engineer-in-chief, Secretary to the Light-House Commission,
charged with the direction of the service.*

To Mr. JENKINS,

Lieut. U. S. N., Secretary Light-House Board of the U. S.

H—No. 3.

A reply to the questions addressed to the engineer-in-chief, secretary to the light-house commission of France, by Mr. T. A. Jenkins, secretary of the light-house board of the United States.

Mr. Jenkins, secretary of the light-house board of the United States, has done me the honor to address to me, in the name of this commission, several questions relative to the light-house service. I will reply to them in succession, following the same order in which they have been put.

1. What have been the increase and improvements in the sea-coast illumination of France since the year 1845?

The reply to this question is shown by the comparison between the annexed list of light-houses illuminated on the 1st January, 1851, and that which was published in 1845. The following table will exhibit this more plainly :

Apparatus.	No. in 1845.	No. in 1851.
<i>Lights of first order.</i>		
Lenticular.	31	*35
Reflector.	4	12
<i>Lights of second order.</i>		
Lenticular.	3	5
Reflector.	1	0
<i>Lights of third order.</i>		
Lenticular.	13	16
<i>Lights of fourth order—Beacons.</i>		
Lenticular.	57	66
Reflectors.	42	40

2. What improvements have been introduced into the Carcel lamps; and are other lamps used?

According to the annexed statement of instructions, published in 1848, upon the service of lenticular lights, three kinds of mechanical lamps were in use at that time, in the lighting of light-houses of the three first orders. They are in use still. Of these the Wagner lamp, the last of the three in the order of invention, is perhaps the one most to be relied upon for regular use; its mechanism is very simple, and it is secured with all necessary solidity. There has just been made, for one of the lights of the first order, which will be shortly lighted at the mouth of the Canche, a lamp with four concentric wicks, placed according to the system of the moderator lamp; except that the spiral spring is replaced by a weight which acts on

* The lights of Algiers and the colonies are not comprised in this table. The two lights of the first order at the mouth of the Canche are not included in this table. It is expected that they will be lighted in a few months.

† These two apparatus will, in all probability, be replaced in 1852 by lenticular apparatus.

the piston, (see description of the moderator lamp, p. 8 of the instructions upon the service of beacons.) This lamp—which would be less expensive than the preceding ones, and more easily kept—has given very good results in the many trials which have been made in the light-house workshops; nevertheless the result of a longer trial will be waited for before applying it to other light-houses.

3. What oil is used?

Colza oil is used in the light-house service. Numerous experiments have proved, that this oil is the best for lighting; it is, moreover, at present the most economical. Some years since the contractors for the furnishing of oil asked authority to substitute for it olive oil, for the lights of Corsica, on account of the difficulty of procuring the oil of colza. They stated, besides, that the first of these oils, properly prepared, was eminently suitable for lighting.

Experiments were then made to compare the two oils. Two lamps of the first order, similarly placed, were filled, one with colza oil, the other with olive oil; they were lighted, and the flame received, as nearly as possible, the same degree of adjustment. Two metallic screens, each pierced with an opening of the same dimensions, were placed before the flames, and at the same height, and the rays of light passing through these openings were measured. This experiment was repeated several times, and it established that the light of the flame from the oil of colza was represented by 1.00; that of the other flame had for its mean value 0.88.

It was proved, besides, that the consumption, by the two flames, at the same graduation, was represented, for the colza oil, 1.00; while that of the olive oil reached 1.137.

The authority asked for was refused.

Other experiments were made, a few months since, on a mineral oil—the oil of schiste. They established that, when the flame was well managed, it gave a light notably superior to that which is obtained from the oil of colza; but when the flame was agitated, or the lamp did not perform perfectly well, it evolved extremely thick smoke, which quickly darkened the apparatus. It would be necessary to have a lamp specially adapted to the burning of this oil. These experiments will be followed up, and they may perhaps lead to satisfactory results; but in the actual state of things, the oil of schiste cannot be applied to light-house illumination.

Some trials have been made with hydrogen gas and with a mixture of hydrogen and oxygen, and they have given good results, as to the quantity of light produced, but the expense would be greater; and, what would be a capital defect, less certainty in the continuance of the light.

4. To what tests are the oils, wicks, and chimneys submitted?

The articles 8, 9, 10, 11 and 12 of the schedule of charges, relative to the furnishing of colza oil, will answer the first part of this question.

As to the wicks and chimneys, they are examined to see if those delivered are conformable to the model deposited in the central workshop for light-houses. There is sent with this note specimens of the different kinds of wicks and chimneys, which, after numerous trials have been definitely adopted for the service of lights.

5. At what periods are the inspections of lights made?

The light-houses are placed in charge of the engineer corps of bridges and roads, (*ponts et chaussées*.) In each district there is an engineer-in-chief and engineers; these last have under their orders agents who have the

title of conductors. Each light is placed under the immediate superintendence of a conductor, who visits it at least once a month, but in most cases oftener.

The engineer never remains more than three months without visiting the lights of his district, and the engineer-in-chief inspects those of his department at least once a year. Finally, the engineer charged with the direction of the light-house service, makes each year an inspection, which embraces one-third of the sea-coast, in order that he may examine each of these establishments at least once during the three years. These visits are made by day and by night. Each conductor is provided with keys by which he may enter unawares, even into the lantern itself, in order to ascertain if the light be attended to, according to the regulations. The port-officers and harbor-masters have orders to transmit to the engineers all complaints from navigators, upon the keeping of the lights.

6. What is the number of keepers to each light?

The number of keepers is fixed at three for lights of the first order, and two for lights of the second and third orders. Beacon-lights have but one keeper; but another keeper is added when these establishments are placed on rocks isolated in the ocean, or uninhabited islands, that these agents may have by turns a regular leave of absence, without exposing the service to suffer therefrom. The detailed estimates of the annual expenses of illumination, will show the number of keepers in each of the light-houses in France.

7. What is the annual expense of repairs to the carcel lamp?

The detailed estimates, which served in 1838 as the basis of the contract for illuminating the light-houses of the ocean and of the Mediterranean, had valued this expense at seventy-five francs per year for the lights of the first order, at sixty-five francs for those of the second order, and at forty-eight francs for those of the third order. This valuation was too large. Thus, in 1850, the expense incidental to this object for twenty-eight lights of the first order, four of the second order, and thirteen of the third order, only reached 917.80 francs, whilst the price before named would bring it to 2,984 francs.

In order to answer Mr. Jenkins's last question, I add to this note some printed documents designated as follows:

Instructions upon the organization and superintendence of the service of lights and beacons—1842.

Schedule of charges and detailed estimates relative to the furnishing of the oil of colza—1848.

Detailed estimates of the annual expenses of the service of light-houses and beacons—1848.

Rules for the keepers of lights and beacons—1848.

Two government circulars (20th and 28th November, 1848) upon the new organization of the light-house service.

Instructions for the service of lenticular lights—1848.

Instructions for the service of beacons—1848.

Circular (20th December, 1848) of the engineer-in-chief, charged with the service of lights.

Light-keepers' book.

Description of the light-houses and beacons lighted on the coasts of France on the 1st January, 1851.

I will add that, since 1845, the construction of lenticular apparatus has

made marked progress, and that the use of curved mirrors, to transmit to the horizon the rays which pass above or below the dioptric drum, are abandoned; these rays are collected by catadioptric prisms, which give them the desired direction by total reflection.

This arrangement produces a notable economy of light, and is eminently favorable to the durability of the apparatus.

I regret to be obliged to give so concise a form to the present note, but the letter of Mr. Jenkins only reached me a few days since, although it was dated the 27th May, and I am on the eve of my departure for an inspection, which will take me from Paris for nearly three months. Yet I am not willing to defer my reply until my return, for this delay would seem long, and might occasion doubts of my lively desire to reply to the honorable appeal of the light-house board of the United States. I hope, moreover, that the accompanying printed documents will furnish all the desirable data in the organization of the light-house service of France; but should I be mistaken, I pray Mr. Jenkins to designate the points upon which any further elucidation may appear to him to be necessary. I will hasten to reply to such inquiries, happy to furnish a great and illustrious nation with that experience which has been acquired by long practice and conscientious studies.

I pray the light-house board of the United States to accept the expression of my sympathy with their labors, and of my respectful devotion.

L. REYNAUD,

*Eng. in Chief, Sec. of the Light-house Commission,
charged with the direction of the service.*

PARIS, July 23, 1851.

P. S. I add to the documents enumerated in the present note, others which might be considered of some use:

1st. Drawing, giving the arrangement of a chimney, surmounted by its regulator, of sheet iron.

2d. Two drawings of models adopted by the French government for the building of beacons.

3d. Directions on the placing of lanterns and of apparatus for lenticular beacons.

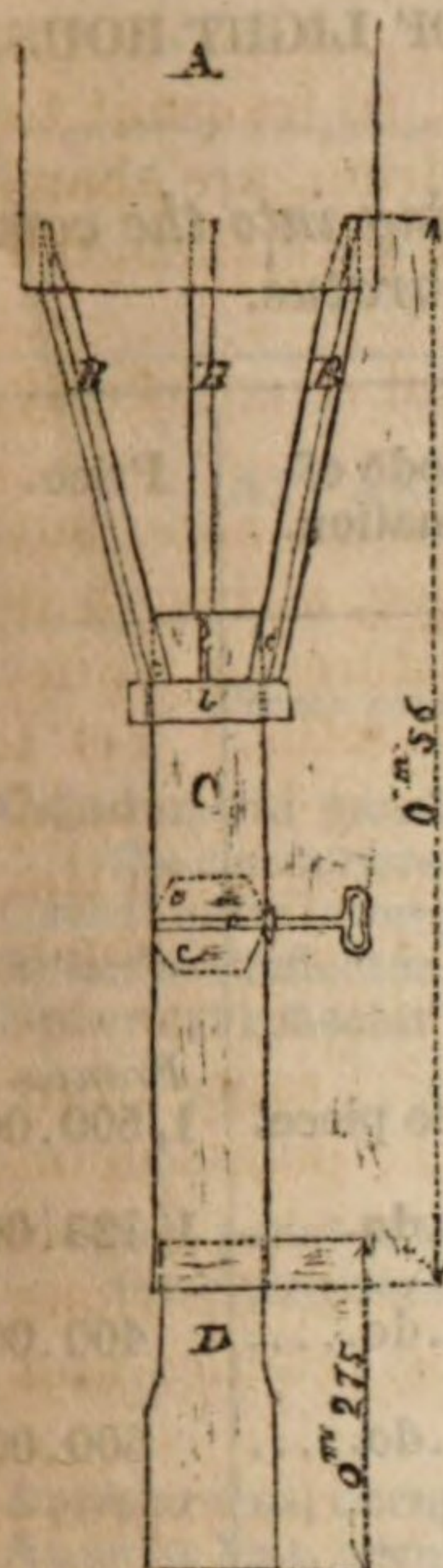
There have been no written instructions for the establishment of light-houses, because this difficult and delicate operation is always directed by one of the conductors attached to the central service.

"COMMISSION DES PHARES,"
Paris, 1851.

1ST ORDER—APPARATUS.

Glass Chimney and sheet-iron Regulator or Damper, in use in France.

REFERENCES.



- A. Copper cylinder fixed above the apparatus.
- B. Support of the regulator.
- b. Collar of the support.
- C. Sheet-iron damper or regulator.
- cc. Four screws.
- c. Key of the damper.
- D. Glass chimney.

H.—No. 3.

COMMISSION DES PHARES,
Paris, October 31, 1851.

SIR: I have the honor to furnish you, in compliance with your request, with a table of the prices adopted by the administration of public works of France, for the principal elements which enter into the composition of light-house apparatus of the different orders.

I will add that Mr. Wagner, the constructor of the mechanical lamps bearing his name, resides at No. 47 Rue Neuve des Petits Champs, and that our agents for supplying colza oil are M. Delarbe, representative of M. M. Desforges & Griard, Passage Violet, No. 2, and M. M. Guillon & Bacquet, No. 3 Rue Pavie au Marais.

Accept, sir, the expression of my high consideration.

L. RENAUD,
The Engineer-in-chief, Director of Lights in France.

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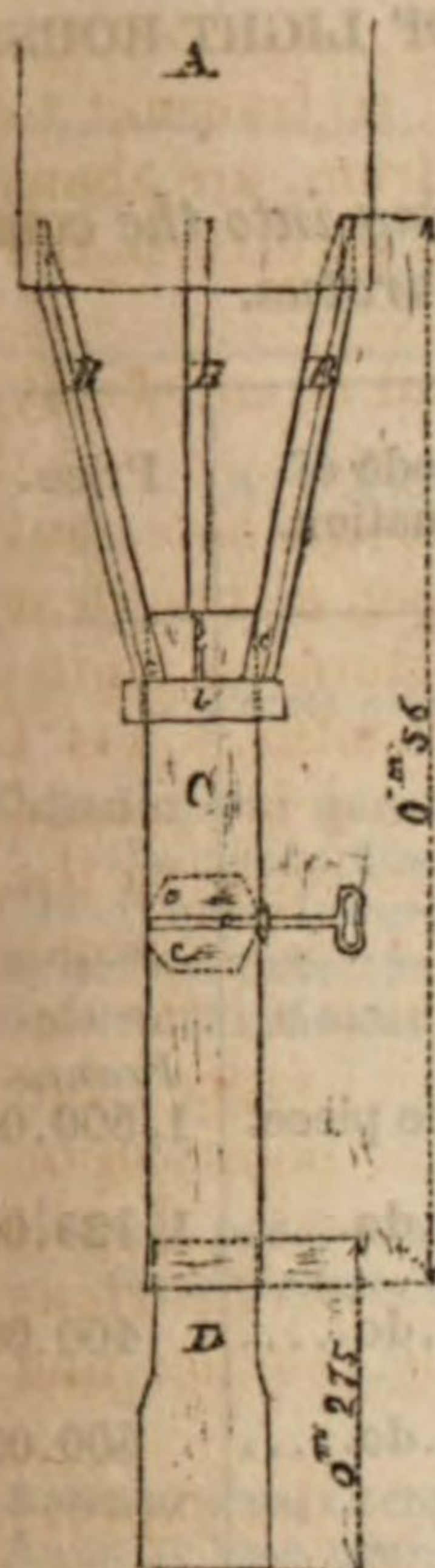
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- A. Copper cylinder fixed above the apparatus.
- B. Support of the regulator.
- b. Collar of the support.
- C. Sheet-iron damper or regulator.
- cc. Four screws.
- c. Key of the damper.
- D. Glass chimney.

H.—No. 3.

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SIR: I have the honor to furnish you, in compliance with your request, with a table of the prices adopted by the administration of public works of France, for the principal elements which enter into the composition of light-house apparatus of the different orders.

I will add that Mr. Wagner, the constructor of the mechanical lamps bearing his name, resides at No. 47 Rue Neuve des Petits Champs, and that our agents for supplying colza oil are M. Delarbe, representative of M. M. Desforbes & Griard, Passage Violet, No. 2, and M. M. Guillon & Bacquet, No. 3 Rue Pavie au Marais.

Accept, sir, the expression of my high consideration.

L. RENAUD,
The Engineer-in-chief, Director of Lights in France.

DEPARTMENT OF THE SEINE—CENTRAL MANUFACTORY OF LIGHT-HOUSE APPARATUS.

Table exhibiting the prices of the different elements entering into the composition of the different orders of light-house apparatus.

Designation of articles.	Mode of valuation.	Price.
APPARATUS OF THE FIRST ORDER.		
I. OPTICAL PORTION.		
<i>1. Pieces common to fixed lights and movable lights.</i>		
Catadioptric panels of the upper crown, embracing one-eighth of the circumference.....	By the piece.	<i>Francs.</i> 1,500.00
Catadioptric lower panels, embracing one-eighth of the circumference.....	do.....	1,125.00
Spherical copper reflector plated, focus 0m.95, occupying one-eighth of the circumference.....	do.....	400.00
Spherical reflector of the same focus and of the same dimensions, of glass.....	do.....	600.00
<i>2. Fixed lights.</i>		
Panels of the drum of fixed lights, occupying one-eighth of the circumference.....	do.....	1,400.00
<i>3. Movable lights.</i>		
Annular lens for movable drum to eight lenses.....	do.....	1,450.00
Annular lens for movable drum to twelve lenses.....	do.....	1,150.00
Annular lens for movable drum to sixteen lenses.....	do.....	700.00
Vertical elements, lenses for fixed lights, varied by flashes.....	do.....	1,250.00
II. MECHANICAL PORTIONS.		
A frame of cast iron, wrought iron and bronze, for fixed light....	complete.	3,860.00
A frame for revolving light, including a fixed frame and movable one, according to the character of the light.....	do.....	5,600.00
Revolving apparatus for revolving light.....	do.....	3,200.00
Portable ladder for the service of the apparatus.....	do.....	120.00
An assortment of three mechanical lamps and their accessories...	do.....	2,100.00
Expense of models, of mounting and dismounting of a fixed frame, comprising adjustments of the optical parts.....	do.....	120.00
Expense of models, of mounting and dismounting the frame of a revolving light, including adjustment of the optical parts...	do.....	150.00
III. LANTERN.		
Wrought iron.....	kilogramme.	2.00
Cast iron.....	do.....	1.25
Bronze or refined copper.....	do.....	5.25
Bronze for screws and bolts.....	do.....	7.50
Brass wire for lightning rod.....	do.....	4.00
Iron bolts.....	by the piece.	0.60
Lightning rod of refined copper 2m.60, with points of platinum...	do.....	200.00
Lion's head.....	do.....	30.00
Spring blinds with bronze fixtures.....	do.....	50.00
Expense of models, mounting and dismounting.....	complete	200.00
Plate glass for upper part of lantern.....	by the piece.	36.00
Plate glass for middle part of lantern.....	do.....	75.00
Plate glass for lower part of lantern.....	do.....	43.00

STATEMENT—Continued.

Designation of articles.	Mode of valuation.	Price.
APPARATUS OF THE SECOND ORDER.		
I. OPTICAL PORTION.		
<i>1. Pieces common to fixed lights and to movable lights.</i>		
Catadioptric panels of the upper crown, embracing one-sixth of the circumference.....	by the piece.	<i>Francs.</i> 1,300.00
Catadioptric lower panels, embracing one-sixth of the circumference.....	do.....	785.00
Spherical reflector of plated copper, one-sixth of the circumference.....	do.....	350.00
Spherical reflector of glass, one-sixth of the circumference.....	do.....	500.00
<i>2. Fixed lights.</i>		
Dioptric panel of the drum of fixed lights, occupying one-sixth of the circumference.....	do.....	1,200.00
<i>3. Movable lights.</i>		
Annular lens, occupying one-sixth of the circumference.....	do.....	900.00
Annular lens, occupying one-twelfth of the circumference.....	do.....	600.00
Vertical elements, lenses for lights with short eclipses.....	do.....	1,000.00
II. MECHANICAL PORTION.		
Frame of fixed light.....	complete.	3,000.00
Frame for revolving light, partly fixed and partly movable.....	do.....	4,260.00
Movable apparatus and its accessories.....	do.....	3,100.00
Portable ladder for the service of the apparatus.....	do.....	120.00
An assortment of three mechanical lamps and their accessories...	do.....	1,790.00
Expense of models, of mounting and dismounting of a frame of a fixed light, including adjustments of optical parts.....	do.....	100.00
Expense of models, of mounting and dismounting of a frame of a revolving light, including adjustments of optical parts.....	do.....	130.00
III. LANTERN.		
Wrought iron.....	kilogramme.	2.25
Cast iron.....	do.....	1.25
Bronze or copper.....	do.....	5.25
Bronze or copper for screws and bolts.....	do.....	7.50
Brass wire for lightning rod.....	do.....	4.00
Spring blinds with bronze fixtures.....	by the piece.	55.00
Lion's mouths in bronze.....	do.....	25.00
Lightning rod of copper with platinum points.....	do.....	160.00
Iron bolts.....	do.....	.60
Expense of models, of mounting and dismounting.....	complete.	150.00
Plate glass for upper part of lantern.....	by the piece.	27.00
Plate glass for middle part of lantern.....	do.....	70.00
Plate glass for lower part of lantern.....	do.....	30.00
LIGHTS OF THE THIRD ORDER.		
I. OPTICAL PORTION.		
<i>1. Pieces common to fixed lights and to movable lights.</i>		
Catadioptric panels, occupying one-fifth of the circumference, and having a diameter of 1m.....	do.....	740.00

STATEMENT—Continued.

Designation of articles.	Mode of valuation.	Price.
		<i>Francs.</i>
Spherical reflector, plated, one-fifth of the circumference	by the piece.	300.00
Spherical reflector of glass one-fifth of the circumference.....	do.....	400.00
<i>2. Fixed lights.</i>		
Dioptric panels, occupying one-fifth of the circumference, for fixed lights 1m in diameter.....	do.....	800.00
Dioptric and catadioptric panels, occupying one-fourth of the circumference, for fixed lights 0m.50 in diameter.....	do.....	750.00
Lion's mouth of bronze.....		
<i>3. Movable lights.</i>		
Annular lens, occupying one-sixth of the circumference, and having a focus of 0m.50.	do.....	800.00
Annular lens, occupying one-sixth of the circumference, with a focus of 0m.25.....	do.....	450.00
Vertical elements, lenses for fixed lights, varied by flashes, focus 0m.50.	do.....	650.00
Vertical elements, lenses for fixed lights, varied by flashes, focus 0m.25.	do.....	300.00
<i>II. MECHANICAL PORTIONS.</i>		
Frame of fixed light of 1m in diameter	complete.	1,800.00
Frame of fixed light of 0m.50 in diameter, with candelabra and table.....	do.....	200.00
Frame of revolving light of 1m in diameter.....	do.....	2,600.00
Frame of revolving light of 0m.50 in diameter.....	do.....	1,300.00
Movable machinery for revolving light of 1m in diameter	do.....	2,000.00
Movable machinery for a revolving light of 0m.50 in diameter....	do.....	1,000.00
For the service of the apparatus of 1m in diameter.....	by the piece.	not allowed.
An assortment of three mechanical lamps of two wicks, with their accessories	complete.	1,250.00
Assortment of three fountain lamps with two wicks, with their accessories.....	do.....	35.00
Assortment of three fountain lamps with one wick, large burner, and their accessories.....	do.....	30.00
Assortment of three moderator lamps with two wicks, and their accessories	do.....	100.00
<i>III. LANTERN.</i>		
Large model 2m.50 interior diameter; small model 1m.80 interior diameter.....	kilogramme.	
Wrought iron	do.....	2.50
Cast iron.....	do.....	1.25
Bronze or copper.....	do.....	5.50
Bronze or copper for screws and bolts.....	do.....	7.50
Brass wire for lightening rods.	do.....	4.00
Iron bolts.....	do.....	0.60
Lion's head.....	by the piece.	20.00
Spring blinds with bronze fixtures, for a lantern of 2m.50 diameter.....	do.....	25.00
Spring blinds with bronze fixtures, for a lantern of 1m.80 diameter.....	do.....	20.00
Lightning rod for lantern of 2m.50.....	do.....	140.00
Lightning rod for lantern of 1m.80.....	do.....	100.00
Expense of models, of mounting and dismounting for a lantern of 2m.50....	complete.	100.00

STATEMENT—Continued.

Designation of articles.	Mode of valuation.	Price.
Expense of models, of mounting and dismounting for a lantern of 1m.80.....	complete.	<i>Francs.</i> 80.00
Plate glass for lantern of 2m.50.....	by the piece.	47.00
Plate glass for lantern of 1m.80.....	do.....	40.00
BEACONS.		
I. OPTICAL PORTIONS.		
An apparatus of 0m.375 in diameter.....	complete.	1,800.00
An apparatus of 0.875 in diameter, lighting three-fourths of the horizon.....	do.....	1,350.00
An apparatus of 0m.30 in diameter.....	do.....	1,000.00
An apparatus of 0m.30 in diameter, lighting three-fourths of the horizon.....	do.....	750.00
Vertical elements, lenses for apparatus of 0m.375.....	do.....	250.00
Vertical elements, lenses for apparatus of 0m.30.....	do.....	200.00
II. MECHANICAL PORTIONS.		
Cast iron candelabra and table of iron for apparatus of 0m.375, and of 0m.30.....	do.....	190.00
Movable frame for light, varied by flashes, for apparatus of 0m.375.....	do.....	1,000.00
Movable frame for apparatus of 0m.30.....	do.....	800.00
Movable machinery and accessories for apparatus of 0m.375.....	do.....	900.00
Movable machinery and accessories for apparatus of 0m.30.....	do.....	800.00
Fountain lamp, large burner.....	by the piece.	24.00
Fountain lamp, small burner.....	do.....	23.00
Moderator lamp.....	do.....	25.00
III. LANTERN.		
Iron for keys and wrench.....	kilogramme.	2.50
Bronze and copper.....	do.....	5.50
Bronze and copper for screws and bolts.....	do.....	7.50
Spring curtains.....	by the piece.	20.00
Expense of models, of mounting and dismounting.....	do.....	40.00
Glass.....	do.....	75.00

Prepared by the undersigned, engineer attached to the central manufactory of light-house apparatus.

E. DEGRAND.

Paris, April 12, 1851.

Examined and certified by the engineer-in-chief of the light-house service of France, Commission des Phares.

L. REYNAUD.

Paris, October 29, 1851.

H.—No. 4.

PARIS, July 28, 1851.

SIR: I have the honor to acknowledge the receipt of your esteemed letter of the 29th May last and the valuable documents which accompanied it.

I observe with great pleasure that the United States government favors the introduction of the lens system of lights, and that a regular organization, similar to that which we have in France, is proposed.

Such an administration, composed of such learned and able men, cannot fail to produce, in a short time, great improvements in the illumination of the coast, and greatly to the advantage of commerce and navigation, which is so extensively and actively carried on in the United States.

You will find herewith, sir, a brief account of the different improvements which I have introduced into the lens system since your visit to Paris in 1846, and the number of lenses which I have constructed since that time.

I hope that the occasion may present itself to enable you to judge, from your own observation, of the importance and value of these changes; and I shall employ all my efforts to merit the approbation of the light-house board, and of yourself.

I have the honor to be, with great respect, your obedient servant,

HENRY LEPAUTE,

Constructor of Lens Apparatus, No. 247 Rue St. Honorè, Paris.

TO MR. THORNTON A. JENKINS,

Secretary to the L. H. Board of the United States of America.

PARIS, July 28, 1851.

Note upon lens apparatus, and upon numerous improvements in the optical and mechanical parts of them, by Henry Lepaute, constructor of lenticular apparatus, No. 247 Rue St. Honorè, Paris, France.

The constant and uninterrupted study, by the undersigned, of the construction and management of lens lights, has enabled him to introduce modifications in the mechanical lamps, which have rendered their repair much easier.

Escapement lamps, upon the plan of Henry Lepaute.

As some inconvenience has resulted from the manner in which the escapements were attached to them, their form has been changed, and they have now had a solidity given to them which remedies that defect.

The levers which bind the escapements to their vertical axes were formerly of unequal lengths, from which it frequently resulted that inattentive keepers sometimes substituted one for the other, thus producing a great inequality in the flow of the oil. Now, however, by a new arrangement these inconveniences no longer exist, and it is found in practice that the management of it is greatly facilitated.

Notwithstanding the perfection to which these escapement lamps have reached, and the great attention given to their management, I have, under the direction of M. Degrand, under engineer to the French light-house

establishment, constructed a new lamp, which seems to combine all the qualities of simplicity, durability, and facility of being repaired, which ought to be expected in this description of apparatus, to make them as near as possible within the range of the comprehension of keepers and others, who are strangers to mechanics.

These new lamps are founded on the system vulgarly called the "moderator." Each lamp is composed of an iron frame, similar to those of the old lamps, supporting a cylindrical reservoir, in which a piston is placed and adjusted, which is charged with regulators of lead in sufficient quantities to elevate it to the summit of the burner; a small steel cylinder, upon which a chain is wound, serves to raise this piston by means of a crank, and in this ascending motion, the oil with which the reservoir is filled above the piston passes beneath; the action of the piston in descending causes the oil then to rise into the burner, and the overflow to fall back upon the same piston.

The extreme simplicity of this lamp, the small number of pieces of which it is composed being very solid, appears well adapted to the service of light-houses, and requires that the keepers should possess but ordinary ability to enable them to manage them.

The undersigned takes the liberty, then, of calling the attention of the light-house commission of the United States to this new system.

Numerous improvements of detail have besides been added to the burners and to the means of carrying off the smoke; the principal change consists in a new ventilator, in which a damper or regulator is adjusted, which by these means does not rest any longer upon the glass chimney of the burner, and permits the exterior current of air, which is introduced by the lower part of the ventilator, to carry off the smoke rapidly from the burner; the strong current giving a more brilliant flash, and preventing the action of the exterior currents of air upon the top of the regulator, diminishes strikingly the breakage of the glass chimneys.

In 1849, the undersigned presented to the French industrial exhibition, at Paris, a lens apparatus of the first order, for short eclipses, upon a new plan, giving in the space of two minutes a flash of sixty seconds duration, followed by an eclipse of twenty-five seconds, which produced a brilliant and powerful flash of ten seconds duration, which was succeeded by another eclipse of twenty-four seconds, and successfully during the entire night.

This apparatus received the approval of the Savans, and the author of it received a new gold medal. It had been constructed by order of Captain Stansbury, for the Carysfort light-house, and was shipped to the United States at the close of the exhibition. I am ignorant of what has since become of it, and its value has not yet been paid to me.

In January, 1850, the undersigned conceived the idea of a new combination of catadioptric apparatus for eclipses, capable of producing flashes equal in duration to the eclipses, and arranged in a manner to show each five seconds a brilliant flash of five seconds duration.

The new character of these lights failed, for we could not reach the result which Mr. Stevenson, of Scotland, had obtained when in giving to the lens apparatus, constructed up to that time, a rotation so rapid that rendered the flash too indistinct, and would not permit the navigator to see it for a sufficient length of time.

A lens apparatus was ordered of the undersigned, by Mr. Lewis, for the Sand Key light, and its execution was well advanced, when, in the month of

March last, the order was received to suspend the further execution of the work ; not having received any new instructions, this work remains unfinished.

This year the undersigned is about arranging a new mode of constructing annular lenses for eclipse lights ; that modification which has also received the approbation of the commissioner of lights in France consists in the new division of the lenses, of which the elements divided vertically will present an angle of four to five degrees, which will greatly increase the duration of the flashes and will shorten equally that of the eclipses.

The French administration is about to order from the undersigned, an apparatus of the first order of this description of flashes for every minute, to renew the apparatus of the light of Ailley, near Dieppe, and another of the same order for eclipses of every thirty seconds for the light of the Baleines, near La Rochelle.

In these new apparatus the lenses which had formerly one metre of elevation are increased to 1m.30.

Last year the undersigned commenced the construction of a lens apparatus of the first order for the Brazilian government, to be placed upon Mount St. Paul, near Bahia. The apparatus of the first order of total eclipses for the new light, is of a combination entirely new. The twelve annular lenses which constituted the dioptric drum are surmounted by twelve catadioptric pannels, transmitting to the horizon the flash of twelve small annular lenses placed in the interior of the apparatus, which augment and prolong strikingly the flash of the lenses.

Above the dioptric drum are placed four fractions of prisms, which, turning with the lenses, add also their power.

In this apparatus the entire optical part is revolving, and there is no fixed light during the eclipse, for it seemed to the undersigned that in consequence of the length of the flashes there would be the advantage of rendering the eclipse total, while the flash of the fixed light of revolving apparatus could not in any case be seen so far as the flash or the lenses ; and besides, it seemed better to increase the intensity of that flash and increase the duration, by rendering the eclipse total. That combination is generally preferred by the officers of the navy to whom the undersigned submitted his plan before putting it into execution.

The result of these modifications is, that the revolving apparatus of the second order would equal the power of the old lens apparatus of eclipse of the first order, and naturally produce a great economy in the acquisition of equality of light.

The difficult construction of these new apparatus renders the diminution of price impossible, and the undersigned refers for their value to the tariff furnished in 1845.

HENRY LEPAUTE,

Constructor of lens apparatus,

No. 257 Rue St. Honore, Paris.

H—No. 5.

PARIS, *August 10, 1851.*

SIR: I had the honor to receive your letter of the 29th May from Washington, on my return to Paris, and hasten to transmit through your legation, agreeably to your request, numerous documents which will serve as replies to the questions which you have been pleased to address to me.

I have the honor to be, sir, your very obedient servant,

T. LETOURNEAU,

Lieut. T. A. JENKINS, U. S. N.,

Secretary to light-house board, Washington,

NOTE UPON LENS APPARATUS.

IMPROVEMENTS IN THE OPTICAL AND MECHANICAL PARTS OF THE APPARATUS.

Considerable improvements have been introduced, or are about to be, in the combination and composition of lens lights. I will treat of them here in a general way, accompanied by a brief description.

Although the most of these improvements are due to my researches, allow me, for the moment, to forget the duty which under all other circumstances, modesty would impose upon me, and attach to each of them the name of the author.

Holophotal apparatus, by Mr. Stevenson. (Plate 1.)

This new combination converts the catadioptric zones into annular zones, thus serving to extend the lenses of the centre, the total height of the optical part of these lenses which is contained between No. 6 of the zones of the lower, and the No. 10 of the lower part. That combination is only applicable to revolving lights, called flashing, every minute or every half minute in all the different orders.

In taking for a basis of prices those indicated in our notices of these apparatus, in so far as relates to the frame and the optical portions, it will be ten per cent. more expensive.

New combination in the lenses of the drum in the apparatus of short eclipses, by T. Letourneau. (Plate 2.)

This arrangement consists in replacing the lenses of vertical elements upon an exterior frame, making its revolution around a drum of a fixed light by a system of fixed light lenses and annular intercalary ones between them; the light will remain in appearance otherwise the same; that new mode presents a useful simplicity, and a striking economy in the cost of the optical parts.

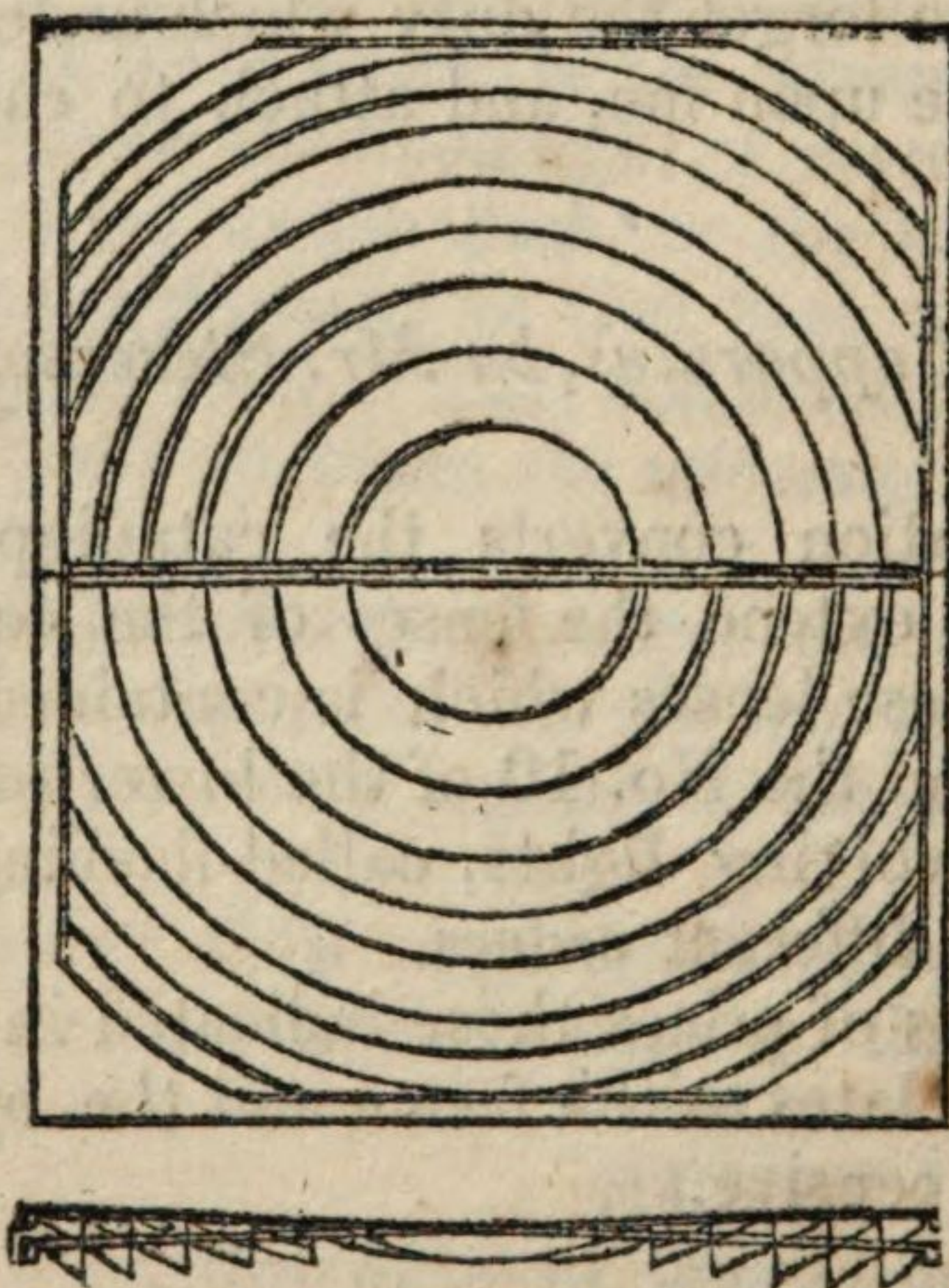
Combinations common to apparatus for revolving lights, either for flashes for every minute, half minute, or for short eclipses, by T. Letourneau. (Plate 3.)

At the same time that Mr. Stevenson made his researches upon his new holophotal lenses, the thought of increasing the intensity of the flashes occupied my attention also. I have constructed an apparatus in which I have applied before these catadioptric zones, the same lenses of cylindrical elements which I reduced to the apparatus for short eclipses, (the emergence of the light which is produced by these catadioptric prisms is, as is well known, the same as in the fixed light drum;) thus placing in the prolongation above and below the central annular lenses, the lenses of prisms converging horizontally. I have obtained in the same point, the coincidence of the flashes of the crown lenses.

Thus composed, this apparatus is found to be materially increased in value, proportionally to the number of supplementary lenses of which it is composed, but the placing, so far as relates to the frame, does not exceed the small increase of 1500 francs, and the solidity of the system presents better assurance of durability and of regularity than those apparatus of the same kind, ordinarily.

Annular lenses to prolong the flashes in revolving lights, (Administration Française.) (Plate 4.)

Fig. 1.



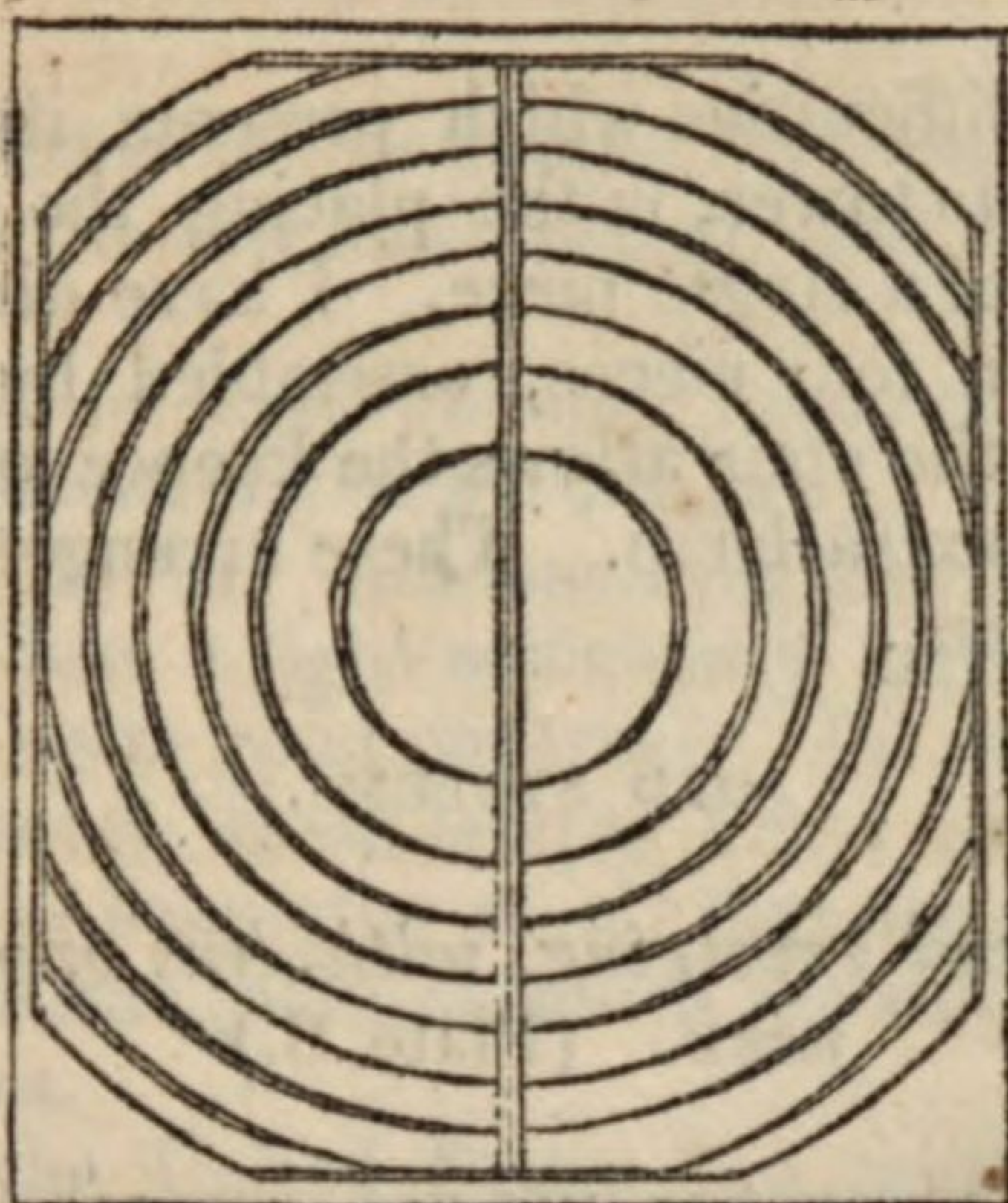
Horizontal section.

The lenses, figure 1, are divided into two parts, and by their centre of figure upon the height; placed in a manner to form an angle of some degrees, the duration of the flashes increases proportionally to that inclination, but at the expense of its intensity. That combination of lenses gives place to an increase of ten per cent. upon the cost of the frame and lenses.

The same lenses for the duration of the flashes, by T. Letourneau.

Encountering considerable difficulty in the construction of the existing frames (the preceding system, however much it may be necessary to regulate the uprights to the demands of the bed of the frame,) in place of dividing horizontally the lenses, I divide them vertically, following figure 2; the

Fig. 2.



Vertical section.

result is absolutely the same. This combination of lenses gives an increase of ten per cent. for each lens.

Revolving lights with alternating movement, by W. Wilkins and T. Letourneau. (Plate 5.)

In a large number of lights, a small angle of the horizon is only required to be illuminated; and if we can, in a fixed light, proportion the number of lenses of the drum to the field of the illumination required; it is not the same in revolving lights, as the drum ought to be complete. Having been solicited by many orders which have been addressed to us, treating of this subject, we have searched for the means by which to realize—

1st. The advantage sufficiently striking in economy which would result from the suppression of several lenses.

2d. That which is not less important in utility by the means of reflectors, of the light directed from the land side. An alternating movable machine, whatever the special disposition of the frame, insures to us a movement very regular of going and coming, which circumscribes the march of the revolving lenses in an eighth or sixteenth of revolution.

Glass reflectors, by T. Letourneau. (Plate 5, figure 2.)

For the old metallic reflectors, the inconveniences of which are appreciated, I substitute reflectors of mirror glass (silvered.) These new reflec-

tors are placed at a distance from the lamp, which varies with the horizontal amplitude, following the number of suppressed pannels, and of the distance of the focus from 0.307 to the back of the reflector against the interior side of the lantern. Let us conceive that the position, the most favorable to place the reflectors is the farthest from the focus, since the divergence is least sensible.

Improvements of detail in construction of frames, table for service, changing the lamps, &c., by T. Letourneau.

One of the greatest difficulties which presents itself in mounting a first order lens apparatus in its tower, is the placing the table of service, which up to this time is made of a single piece. I have divided them in the lights which I have fitted up in four pieces, assembled by screws and nuts; an opening arranged under the stair allows the keeper of the watch to place alone and instantly the extra lamp. These arrangements increase the price of the frame three per cent.

OLD SYSTEMS.

Floating lights, fixed and revolving, with lens apparatus, by T. Letourneau. (Plate 6.)

The floating lights at present in use are composed of a greater or less number of metallic parabolic reflectors, adjusted around the masts of the vessels upon which they are placed. They are divided into fixed lights, varied by flashes. Besides the inconvenience due to the multiplication of lamps, there is not a sufficient quantity of light produced by this apparatus.

NEW SYTSEMS.

The new floating lights are, in the first place, of four refracting apparatus for fixed lights, embracing an angle of 212 degrees. Secondly, of spherical reflectors, making for the optical part the same focus which it should have with the horizontal amplitude of 148 degrees. These apparatus represent very nearly a weight equal to that of eight reflectors which they replace, and an illumination each by a lamp consuming 0.045 grammes per hour.

They are placed in suspension, equidistant from each other, and in whatever manner, always directed to the horizon, and whatever point occupied by the observer, a light greatly increased.

The prices of these apparatus are fixed for the set of four optical parts, reflectors and lamps, 4,800 francs. For the lantern, 3,000 francs. In general the old lanterns may be used for new apparatus.

Revolving machinery for floating lights, by T. Letourneau. (Plate 3, figure 3.)

As much from communicated as personal observation, I have been convinced of the inconveniences arising from the placing of rollers between plane parallel surfaces, as very little time suffices for them to make a succession of hachures or indentations sufficiently marked to change the regularity of the revolutions, and in the hands of incompetent keepers are operations of difficulty.

To obviate these inconveniences, this is the way I have proceeded. Preserving the same number of rollers, I caused them to be placed between two conical surfaces having a common centre; in that way I have obtained the regular development of movement following the generation of the surface of revolution.

*Lens apparatus for lighting sea steamers from their wheel-houses and bows,
by T. Letourneau.*

I find myself conducted in descending the ladder of applications of optics, to acquaint you with the last modification, that of lights to prevent collision at sea.

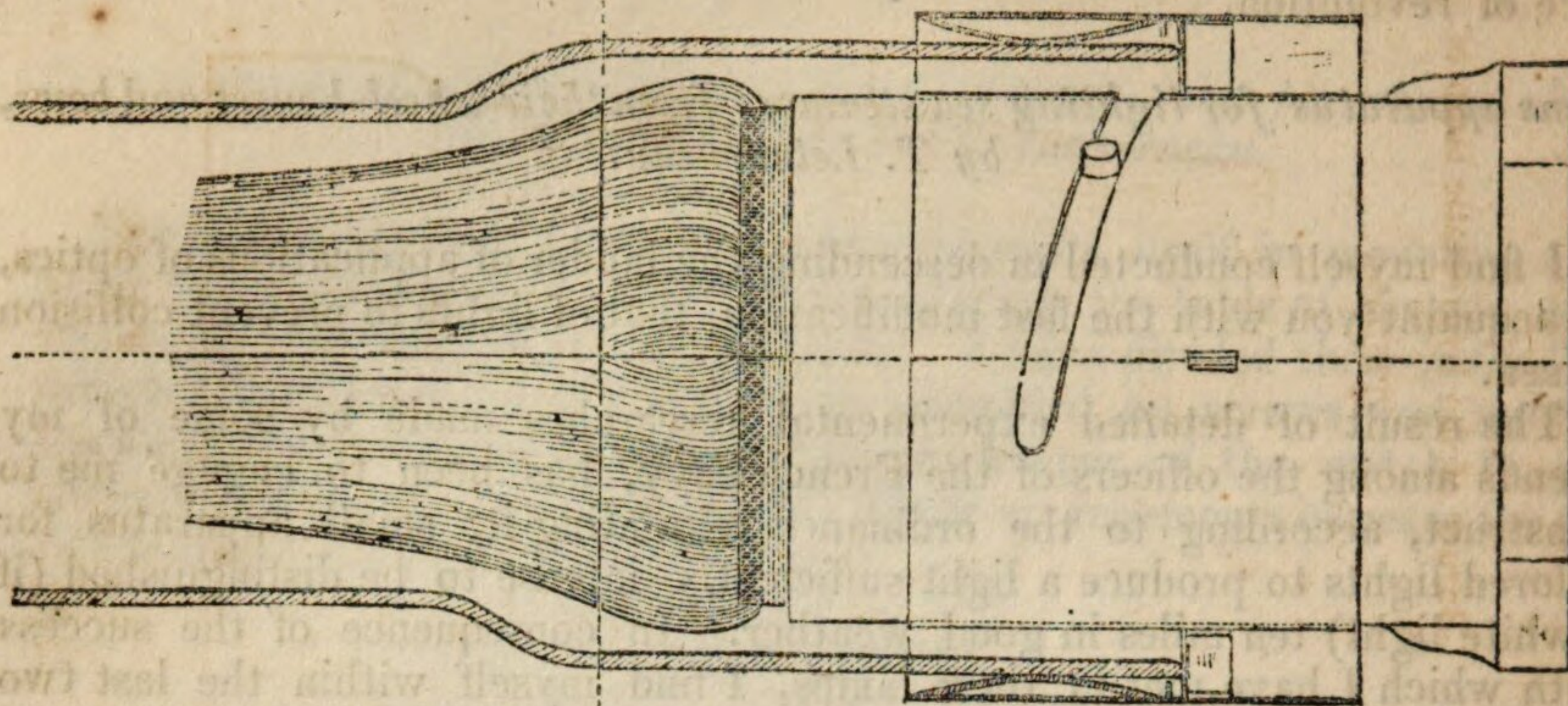
The result of detailed experimental researches made by some of my friends among the officers of the French navy, has been to engage me to construct, according to the ordinance regulating it, small apparatus for colored lights to produce a light sufficiently intense to be distinguished (if a white light) ten miles in good weather. In consequence of the success with which I have met in these lamps, I find myself within the last two years charged with the supplying of all that are required for the navy and for the commercial marine, both of which are subjected in the ordinance to the same general rules.

I do not know if the United States has taken steps in this important matter similar to those of the British Parliament and of the ordinance of Gen. Cavaignac, to insure a uniformity in the manner of distinguishing steamers at night at sea, and to determine at considerable distances the courses steered.



FRANCE.

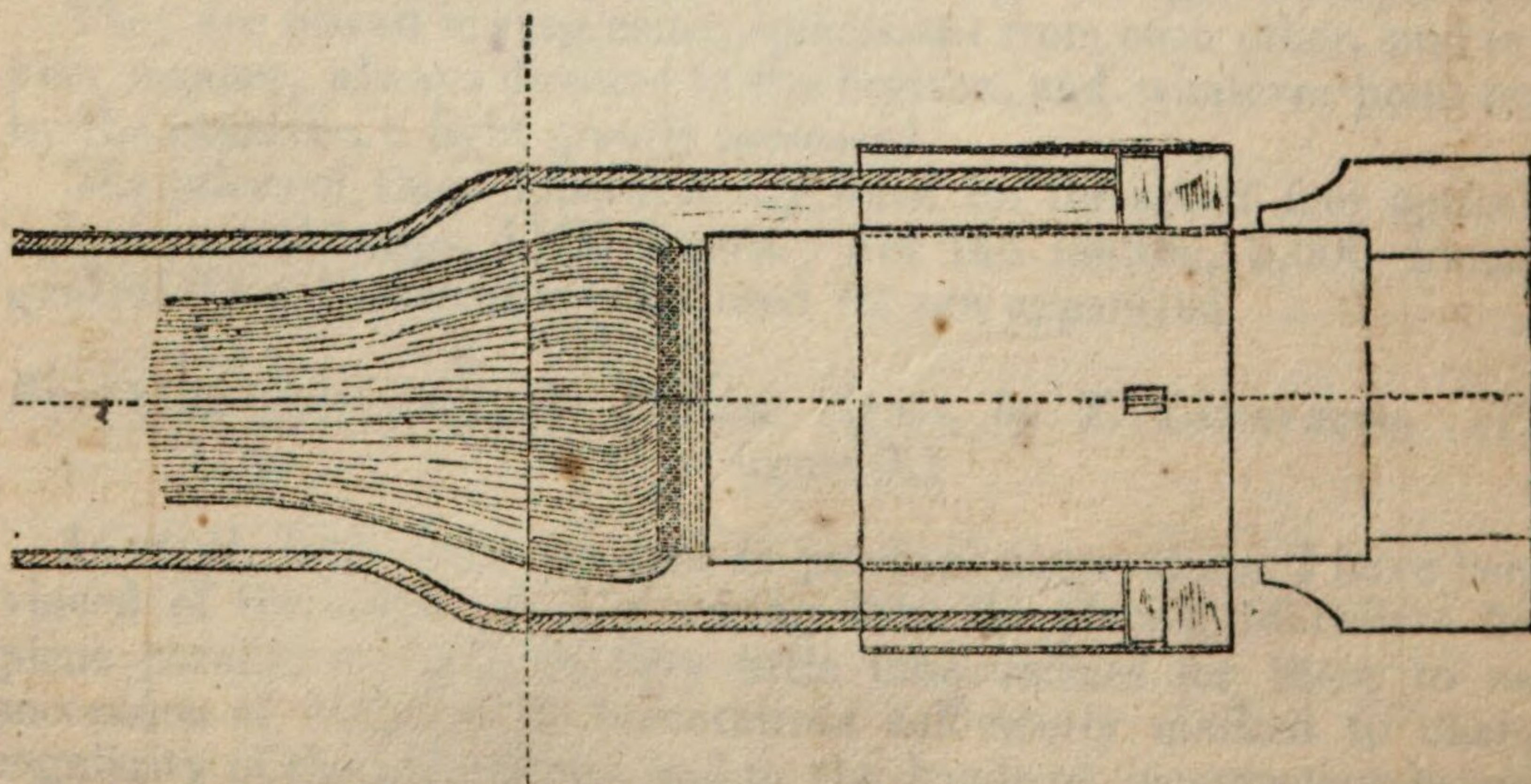
FLAME ONE-THIRD FULL SIZE.



Burner of a mechanical lamp of the first order.

FRANCE.

FLAME ONE-HALF FULL SIZE¹



Burner of a mechanical lamp of the third order.

FRANCE.

BURNERS OF CATADIOPTRIC SMALL LIGHTS, FOURTH ORDER.

Burner of the hydrostatic lamp of

Thilorier.

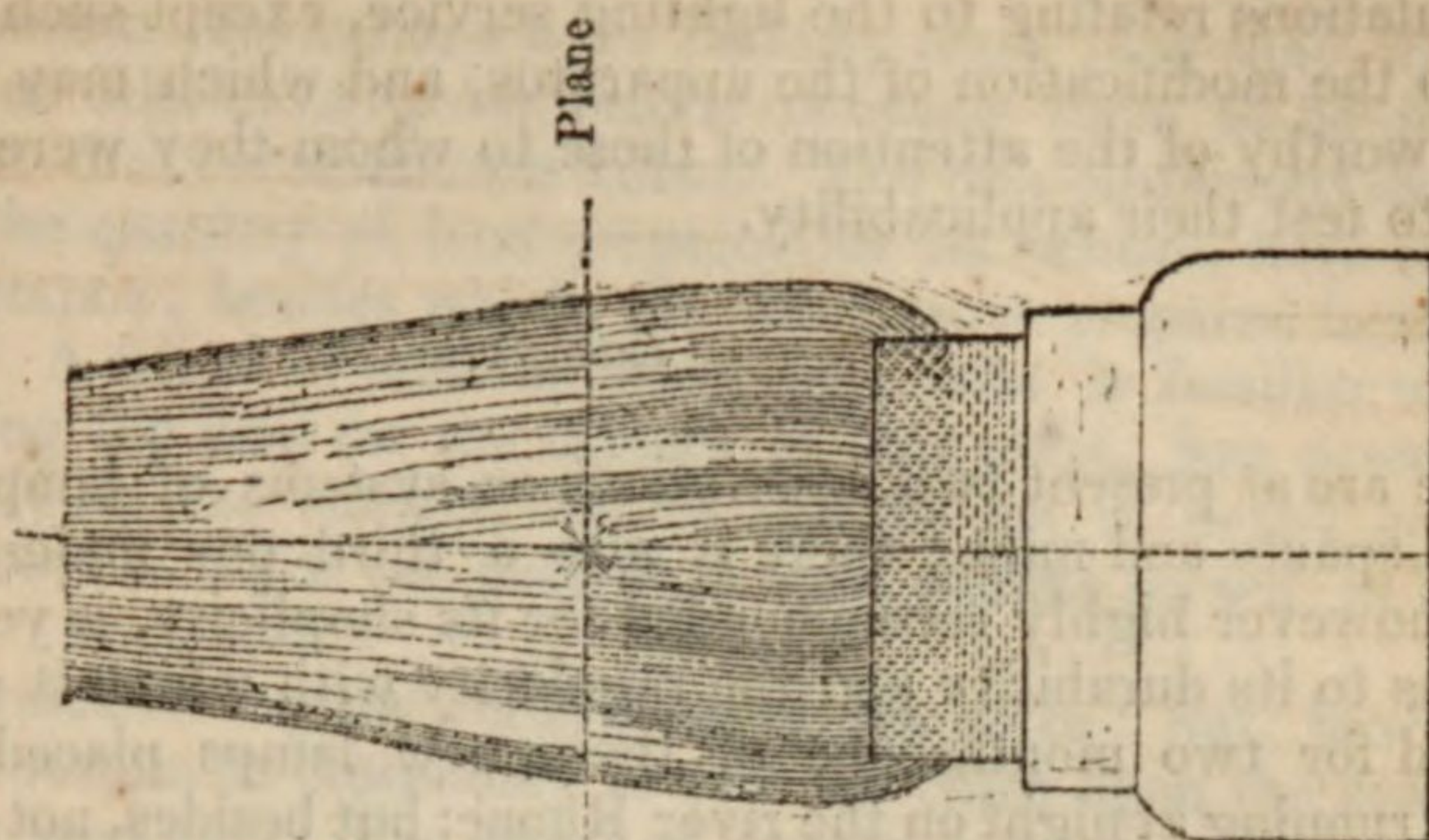


Fig. 38.

Burners of ordinary constant level lamps.

small caliber

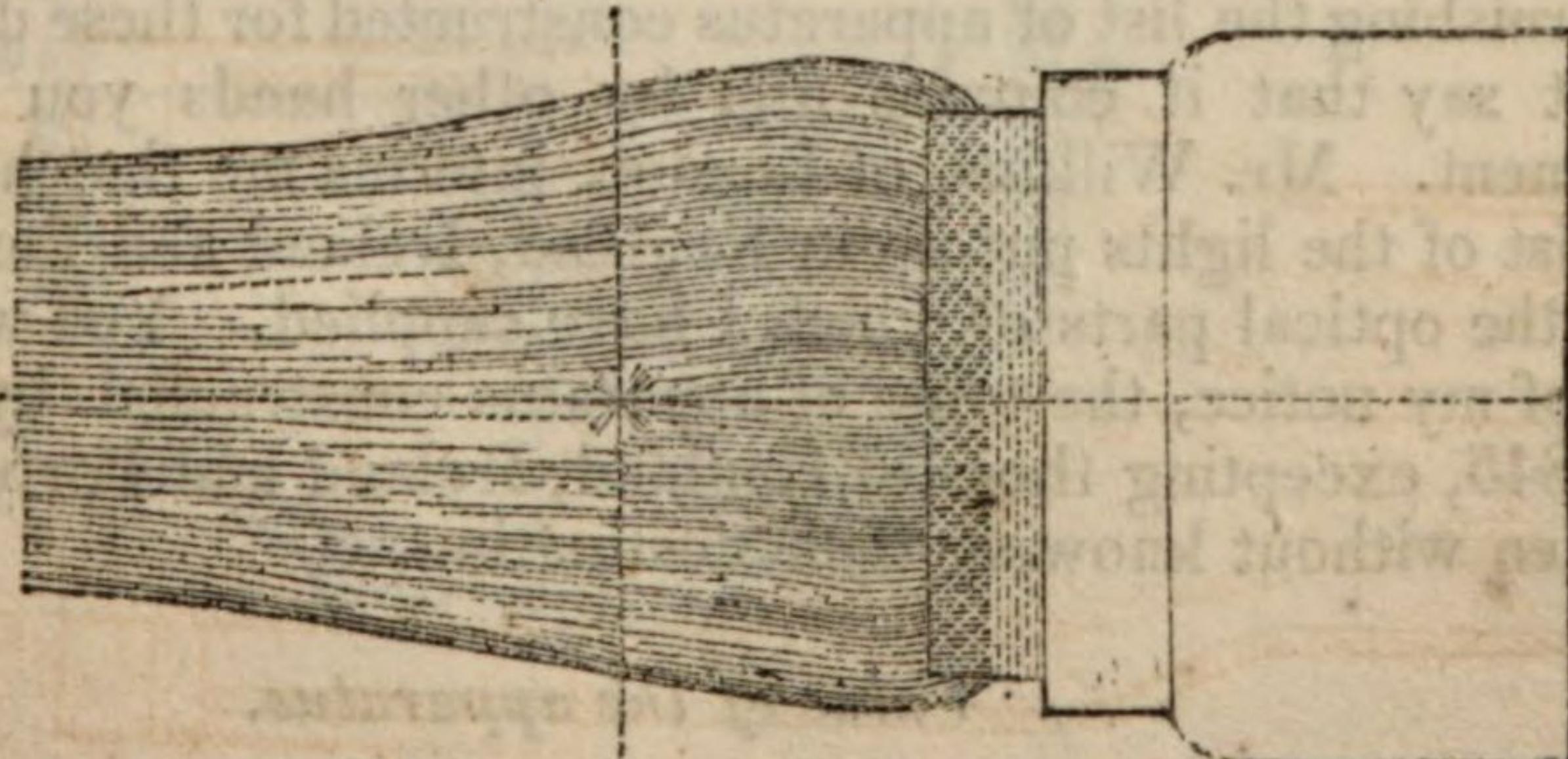


Fig. 36.

large caliber

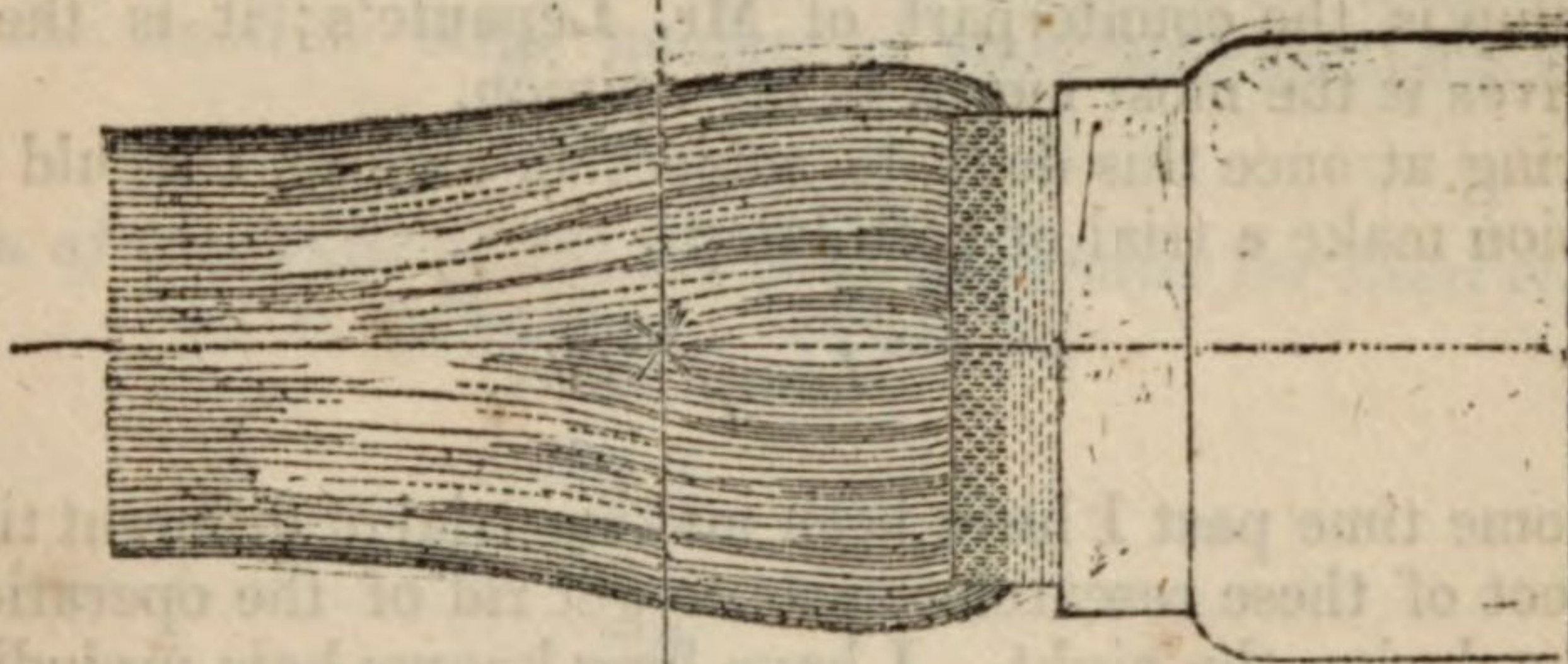


Fig. 37.

Flames in full

SERVICE AND REPAIR OF THE APPARATUS.

No changes worthy of note, so far as I know, have been introduced into the regulations relating to the lighting service, except such as relate specially to the modification of the apparatus, and which may have been considered worthy of the attention of those to whom they were entrusted with a view to test their applicability.

Lamps.

There are at present two descriptions or systems of lamps, that of Mr. Henry Lepaute and mine; there is also a third one undergoing trial, but which, however highly recommended for its simplicity, is yet suffering from doubts as to its durability and the regularity with which it will perform. I have had for two months one of these new lamps placed on board of a steamer running at night on the river Rhone; but besides, not having received reliable intelligence in relation to it, that experiment would not prove any thing, even if it were satisfactory. The present question is between the two first lamps.

As you are already aware, sir, that while M. Henry Lepaute's lamp succeeded the Carcel lamp, mine has succeeded his. The system of M. Henry Lepaute was announced, at its introduction, as possessing superior qualities of combination, while mine has travelled on its own way noiselessly.

My lamp is the counterpart of Mr. Lepaute's; it is the solidity of it which gives it the most merit, in my opinion.

To bring at once this delicate subject to a close, I would desire that the commission make a trial of both lamps.

Lamp wicks.

For some time past I have been making trial of different tissues for wicks. The object of these researches was to get rid of the operation of trimming the wicks during the night. I have long known how prejudicial the operation is to the service, but I have been compelled to abandon the subject.

Lens apparatus constructed by me for France, England, Scotland, Ireland, Spain, &c., since 1835.

In furnishing the list of apparatus constructed for these different countries, I cannot say that it contains all; by other hands you will receive the complement. Mr. Wilkins, of London, informs me that he will forward to you a list of the lights put up in England, Ireland and Portugal; the great part of the optical parts of which I have supplied. You will find from page 3 to 7 of my notice, the table of apparatus constructed by me before and since 1845, excepting those of England, Ireland and Portugal, which I have sent often without knowing their destination.

Value of the apparatus.

The price of the apparatus has not changed.

Oil for illuminating light-houses.

All the experiments which have been making for a long time upon the different kinds of oils, have given results showing them to be in every respect inferior to that obtained from colza. The rich oleaginous quality of that grain, and the quantity of land prepared for its culture, have rendered it of great importance; besides which, the oil is now prepared in the most perfect manner. A friend of mine in Normandy, who is familiar with the modes of preparing the land for the culture of this plant, has promised to address me shortly on the subject, and furnish to me in detail an exact account of the process. For the present, I must confine myself to the following hints:

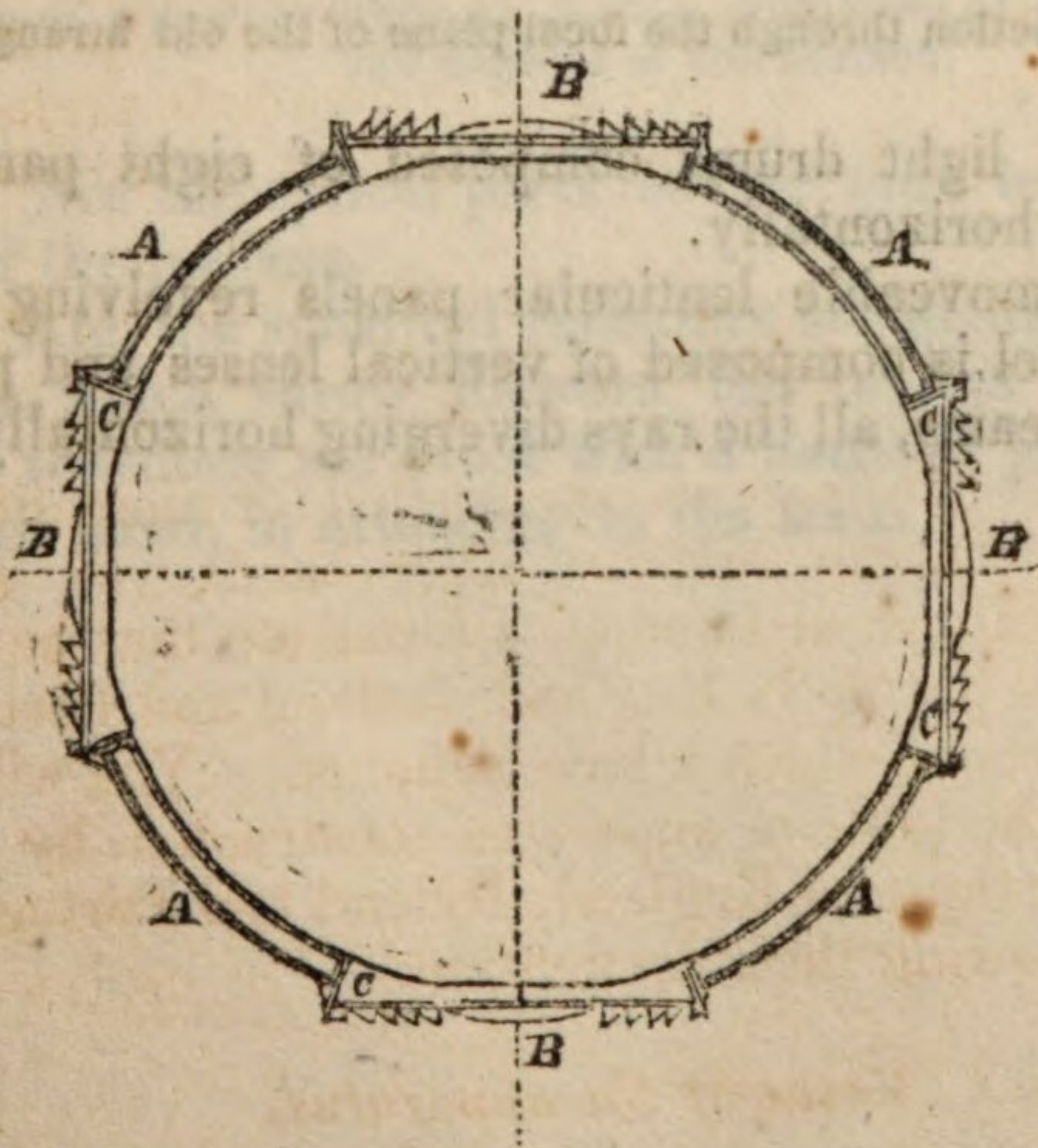
Rich land is preferred for the cultivation of the colza; but, however, it is commonly the custom in Normandy to sow the colza upon the fields from which wheat has been cut. The north of France is its peculiar region.

Markets.

The principal markets for colza oil are: for the north of France, Lille and Coutrai, and for the west, Caen and Rouen. The price is necessarily variable, its average rate is 72 francs the hectoliter for the first quality clarified.* The prices may differ greatly at certain ports for transshipment, depending upon the small or large number of emigrants applying for passage.

*New combination of the lenses of the drum in apparatus for short eclipses,
by T. Letourneau. (Plate 2.)*

Fig. 1.



Horizontal section through the focal plane of the new arrangement.

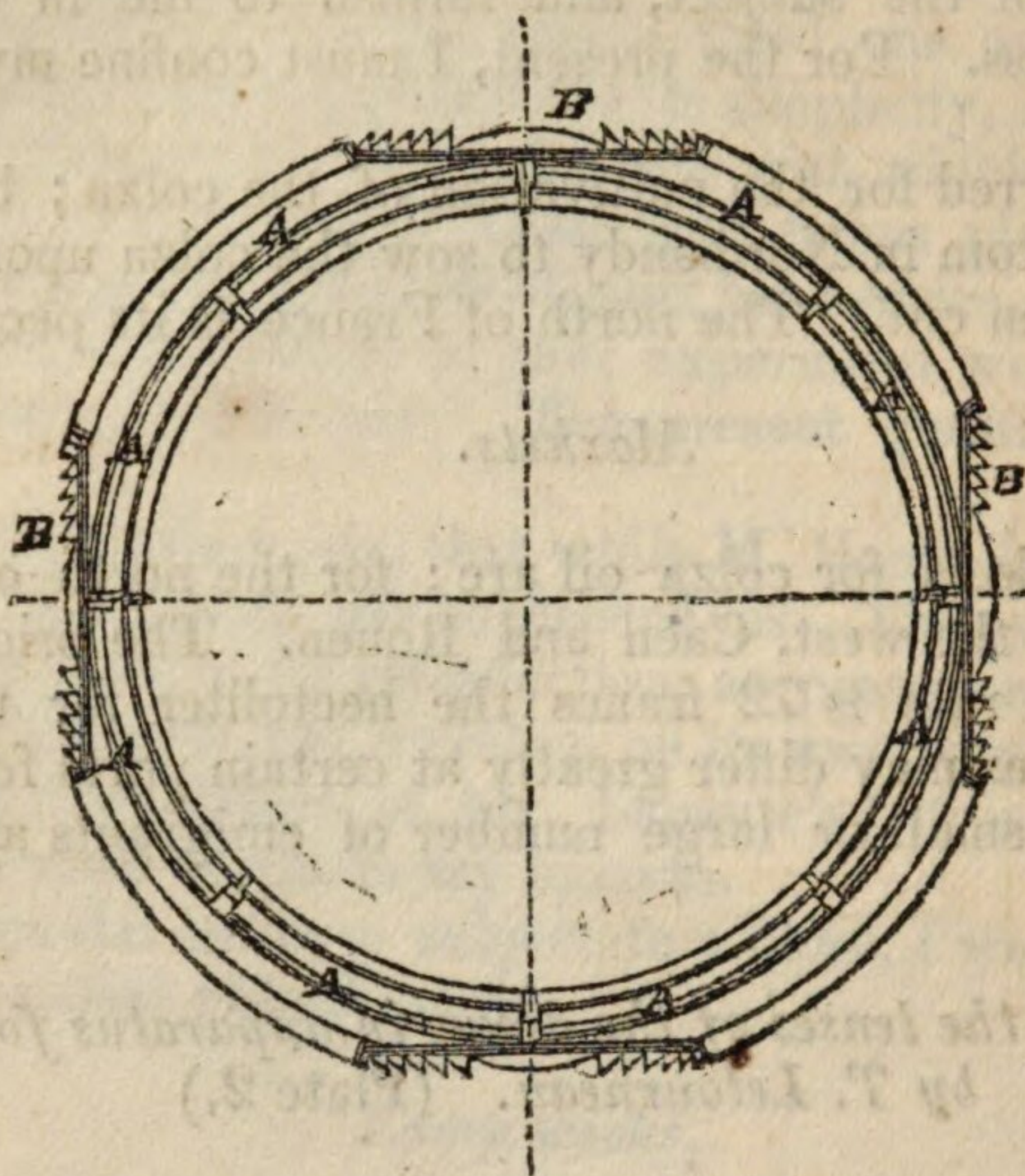
* A hectoliter is a little over 26 gallons, making the price of the first quality clarified colza oil in France 55½ cents per gallon, while sperm oil ranges in this country from \$1 20 to \$1 50 per gallon.

A A A A. Four lenticular cylindrical panels, having the same effect as the drum of a fixed light apparatus of figure 2.

B B B B. Four lenticular panels composed of lenses and prisms, transmitting in parallel beams all the rays of light emanating from the focus.

These eight lenses are fixed upon a movable frame *c c c c*, which by a rotary movement around the axis, produces in a given time successive flashes and eclipses.

Fig. 2.



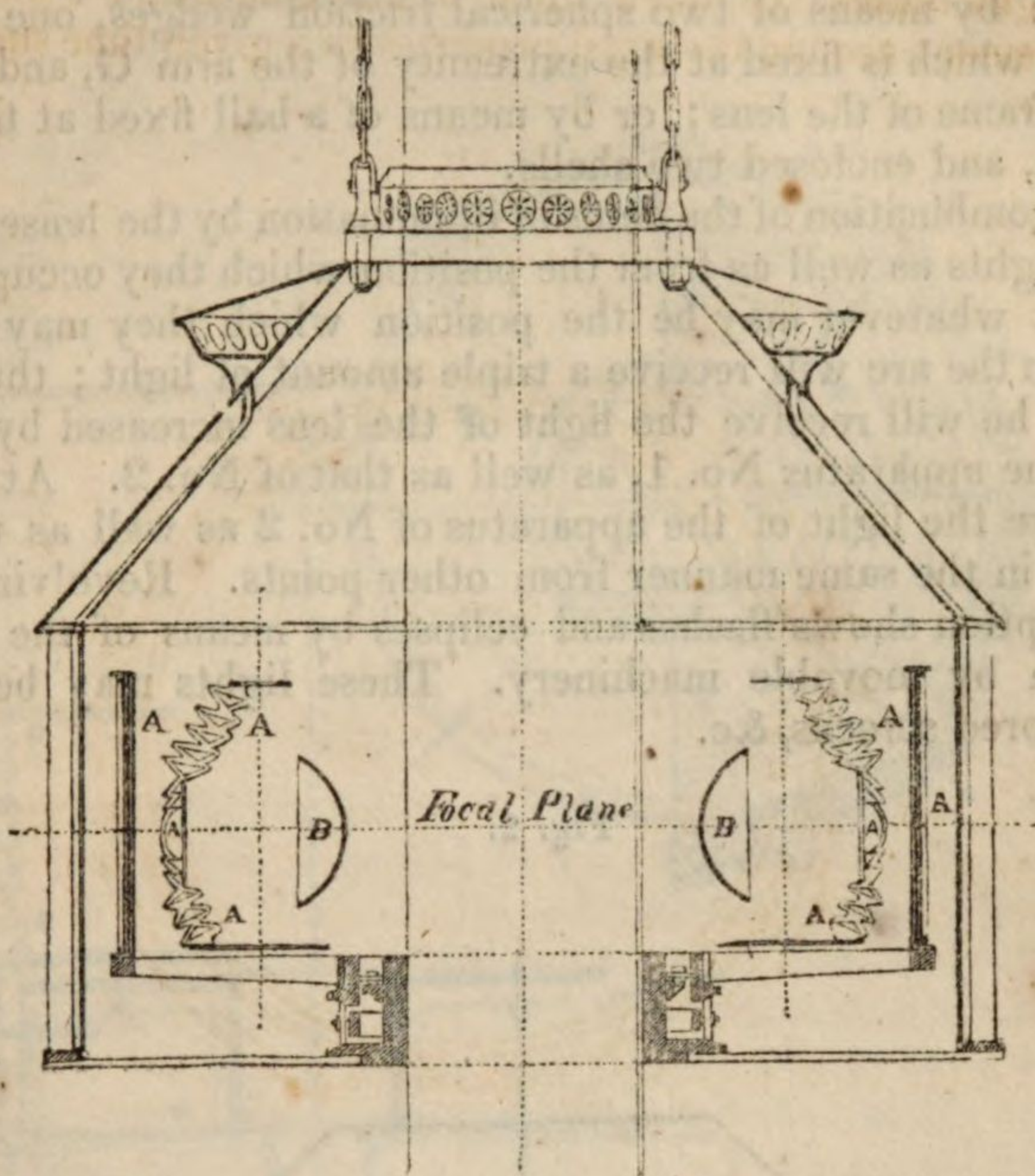
Horizontal section through the focal plane of the old arrangement.

A A A A. Fixed light drums composed of eight panels, converging vertically, diverging horizontally.

B B B B. Four moveable lenticular panels revolving around a fixed apparatus; each panel is composed of vertical lenses and prisms, throwing forward, in parallel beams, all the rays diverging horizontally from the focus.

Improvements in apparatus for floating lights and applying the lens to that purpose, by T. Letourneau. (Plate 3.)

Fig. 1.



Vertical section of a floating light apparatus, composed of four lenses illuminating each 236 degrees of the horizon.

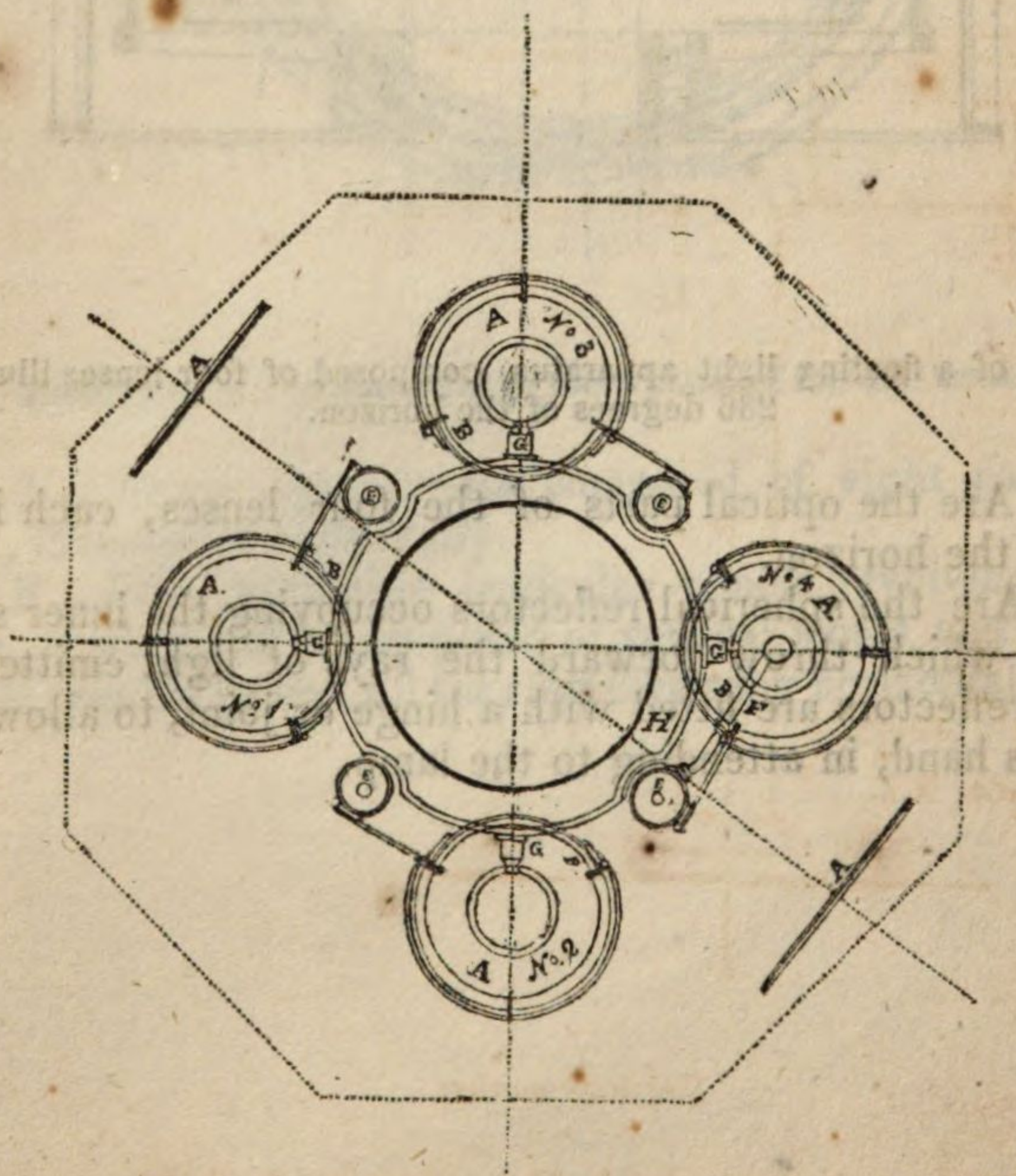
A A A A. Are the optical parts of the four lenses, each illuminating 236 degrees of the horizon.

B B B B. Are the spherical reflectors occupying the inner sides of the apparatus, and which throw forward the rays of light emitted from the focus. These reflectors are fitted with a hinge or joint, to allow the keeper to introduce his hand, in attending to the lamp.

E E E E. Are the reservoirs of the four fountain lamps, the tubes for conducting the oil of which are shown at **F**. This apparatus may in some cases be reduced to two. It is suspended vertically by means of the iron arms **G** fixed to the frame at **H**. The counterpoise is placed as near as possible to the centre of the apparatus, with the view to keep the weights in equilibrium and to regulate the areas of oscillation, which is accomplished in two ways: by means of two spherical friction wedges, one against the other, one of which is fixed at the extremity of the arm **G**, and the other in the metallic frame of the lens; or by means of a ball fixed at the extremity of the arm **G**, and enclosed two shells.

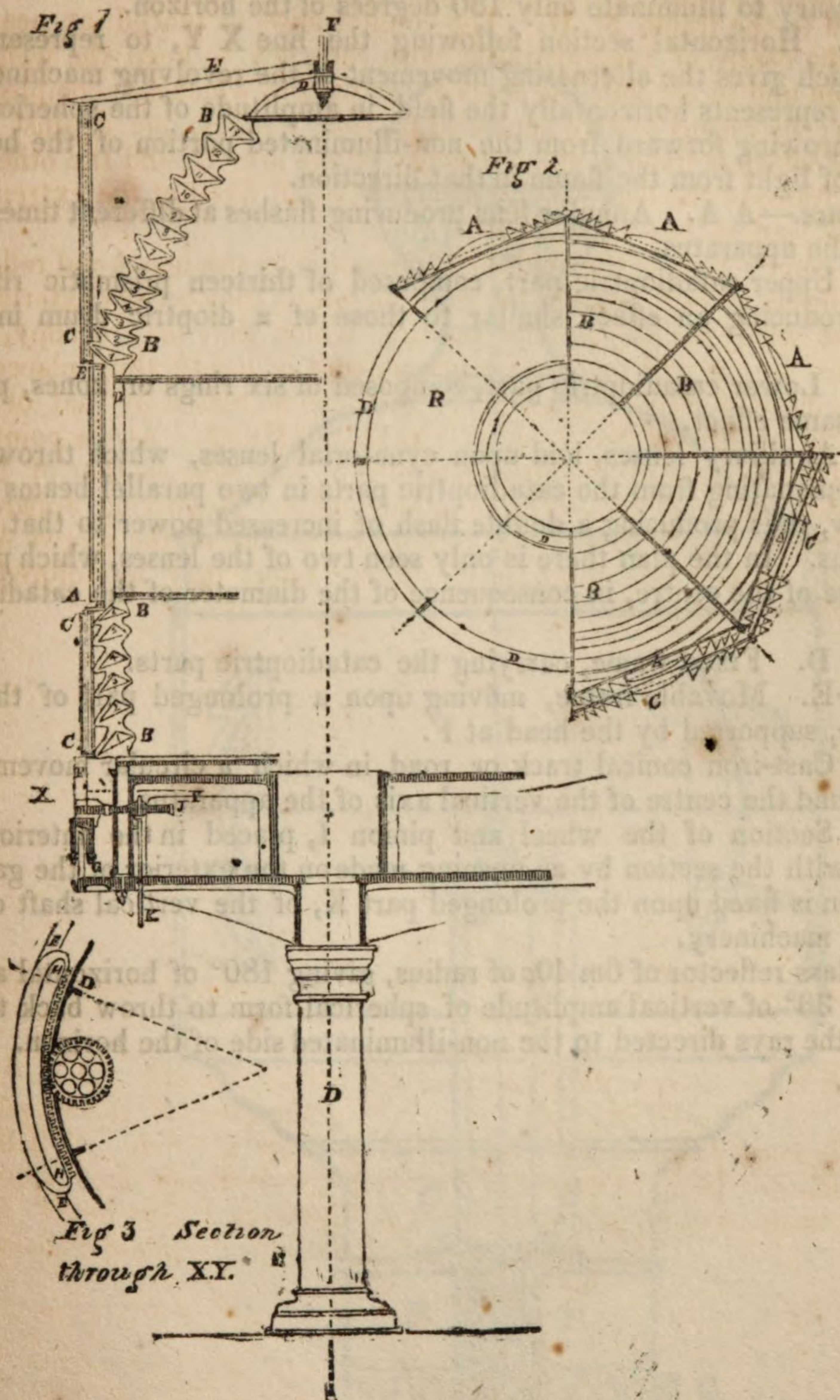
From the combination of the fields of illumination by the lenses and reflectors of these lights as well as from the position which they occupy exteriorly, it results that whatever may be the position which they may occupy, the observer upon the arc will receive a triple amount of light; thus, placed at the point **G**, he will receive the light of the lens increased by that of the reflector of the apparatus No. 1, as well as that of No. 2. At the point **G**, he will receive the light of the apparatus of No. 2 as well as that of Nos. 1 and 3, and in the same manner from other points. Revolving apparatus of this description shows flashes and eclipses by means of the screws **A A**, put in motion by movable machinery. These lights may be colored by means of colored screens, &c.

Fig. 2.



Horizontal section.

Alternating movement lens apparatus. (Plate 5.)



Vertical section.

Fig. 1. Vertical section through the axis of flashing apparatus with auxiliary lenses applicable to flashing lights—those of every minute, every half minute, and of short eclipses.

The new arrangement of the machinery in revolving lights, making the movements of the lenses alternate, is applicable to all lights of the system which do not require to illuminate more than a certain number of degrees of the horizon.

Fig. 2. General plan above the apparatus, indicating a special disposition of this system, applicable to a first order light of every minute, where it is necessary to illuminate only 180 degrees of the horizon.

Fig. 3. Horizontal section following the line X Y, to represent the wheel which gives the alternating movement of the revolving machinery.

Fig. 2 represents horizontally the field in amplitude of the spherical reflector, throwing forward from the non-illuminated portion of the horizon the rays of light from the flame in that direction.

Reference.—A A. Annular lens producing flashes at different times from those of the apparatus.

B B. Upper catadioptric part, composed of thirteen prismatic rings or zones, producing an effect similar to those of a dioptric drum in fixed lights.

B' B'. Lower catadioptric part, composed of six rings or zones, producing the same effect.

C C. Auxiliary lenses, laid upon cymatrical lenses, which throw back the rays emanating from the catadioptric parts in two parallel beams above and below, thus producing a double flash of increased power to that of the central lens. In the plan there is only seen two of the lenses, which project upon those of the centre, in consequence of the diameter of the catadioptric parts.

D D D D. Fixed frame, carrying the catadioptric parts.

E E E E. Movable frame, moving upon a prolonged part of the service table, supported by the head at F.

G G. Cast-iron conical track or road in which a circular movement is made around the centre of the vertical axis of the apparatus.

H H. Section of the wheel and pinion I, placed in the interior and catching with the section by an opening made on the exterior of the gallery. The pinion is fixed upon the prolonged part K, of the vertical shaft of the revolving machinery.

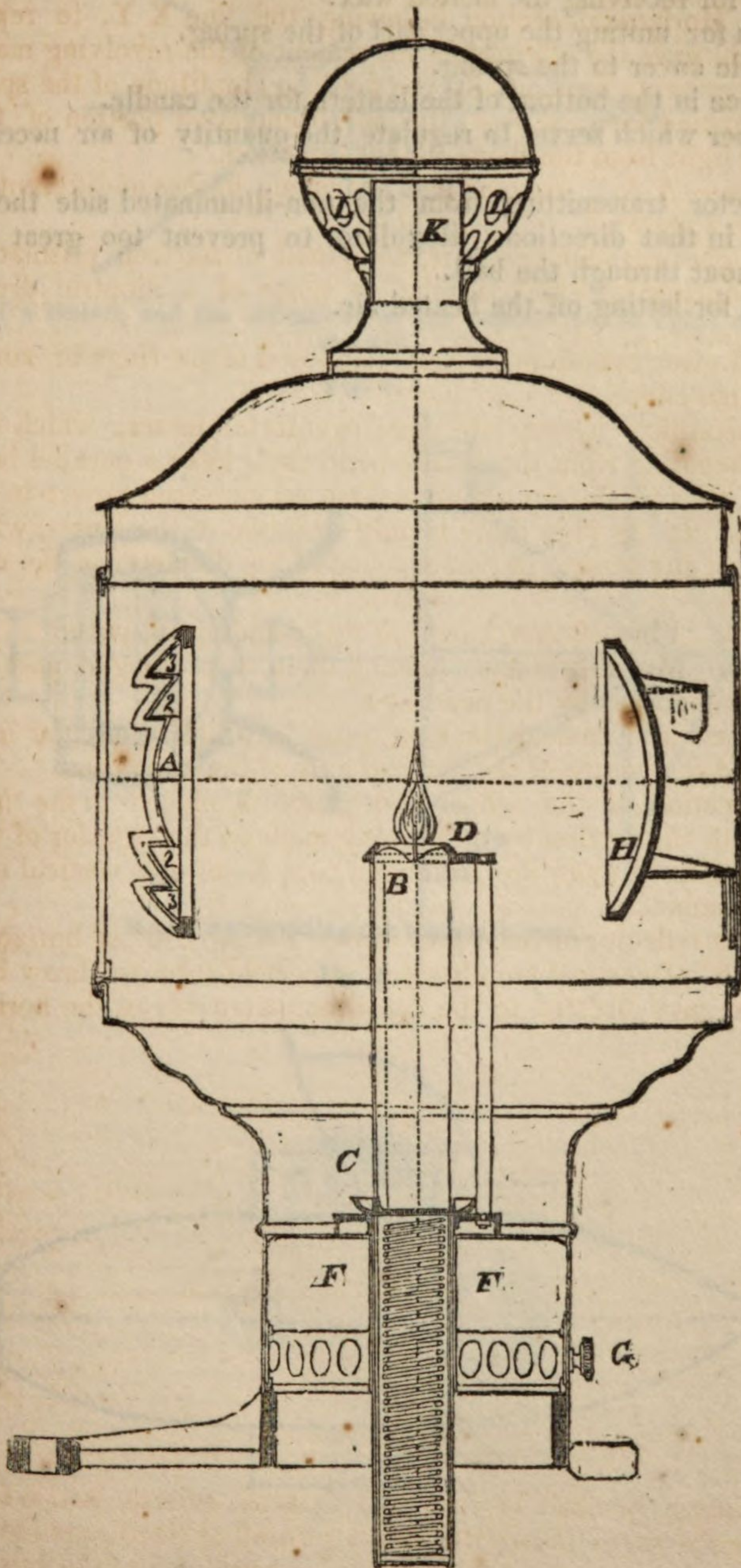
R. Glass reflector of 0m 40c of radius, giving 180° of horizontal amplitude, and 30° of vertical amplitude of spherical form to throw back to the focus all the rays directed to the non-illuminated side of the horizon.

Vertical section

Fig. 1. Vertical section through the axis of flashing apparatus with auxiliary lenses applicable to flashing lights—those of every minute, every 15 minutes, and of short eclipses. The new arrangement of the machinery in revolving light, making the movements of the lenses alternate, is applicable to all lights of the system which do not require to illuminate more than a certain number of degrees of the horizon.

Lens lanterns for sea steamers, by T. Letourneau. (Plate 7.)

Fig. 1.



Vertical section through the axis of the lantern.

- Reference.*—A. Optical parts composed of five elements.
 B. Flame formed by a wax candle, which is forced up to the proper height for burning by a spiral spring beneath.
 C. Cups for receiving the melted wax.
 D. Rings for uniting the upper part of the spring.
 E. Double cover to the spring.
 F. A place in the bottom of the lantern for the candle.
 G. Damper which serves to regulate the quantity of air necessary for the light.
 H. Reflector transmitting from the non-illuminated side the rays of light thrown in that direction. Regulator to prevent too great a rush of air from without through the ball.
 L. Holes for letting off the heated air.

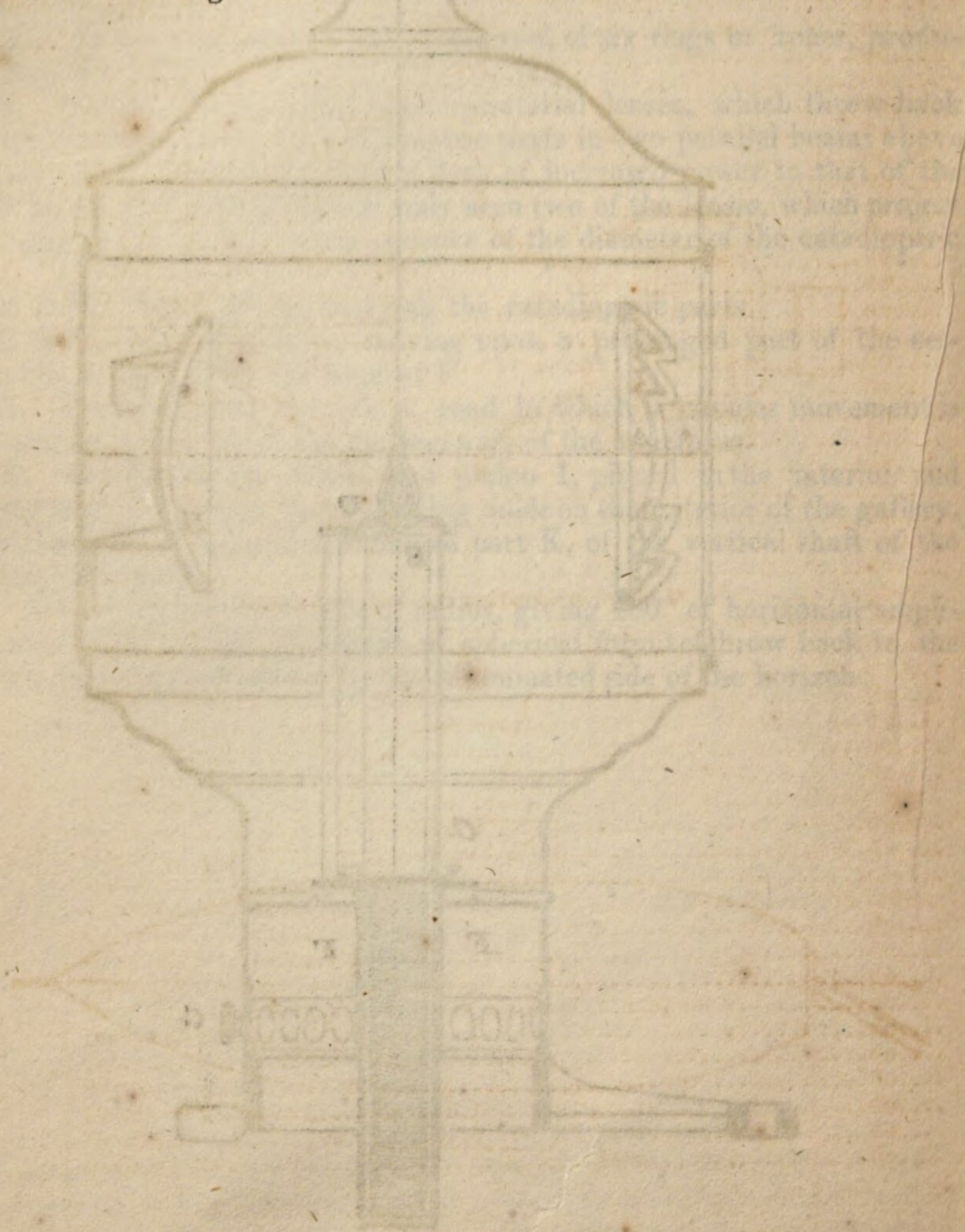
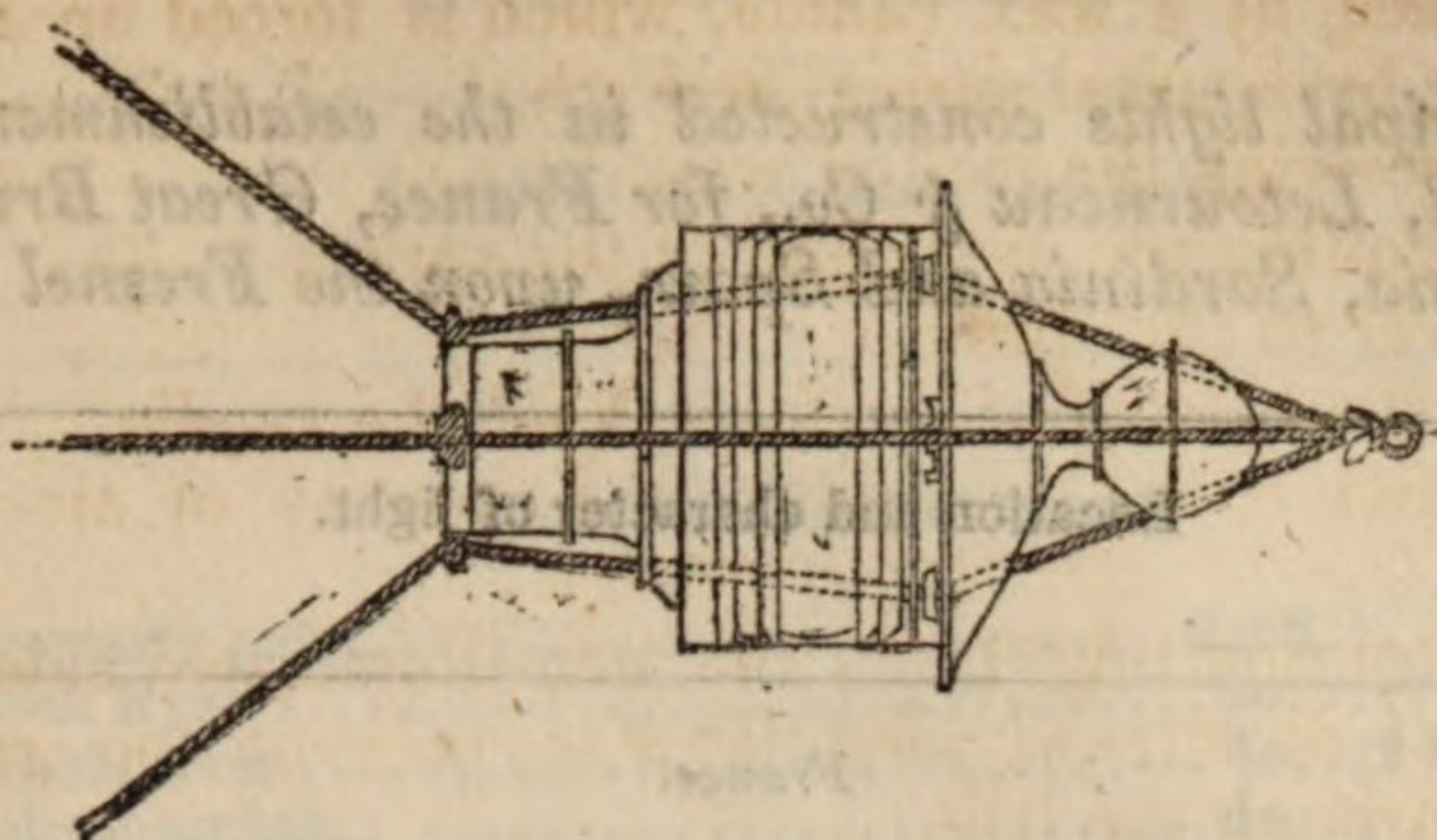
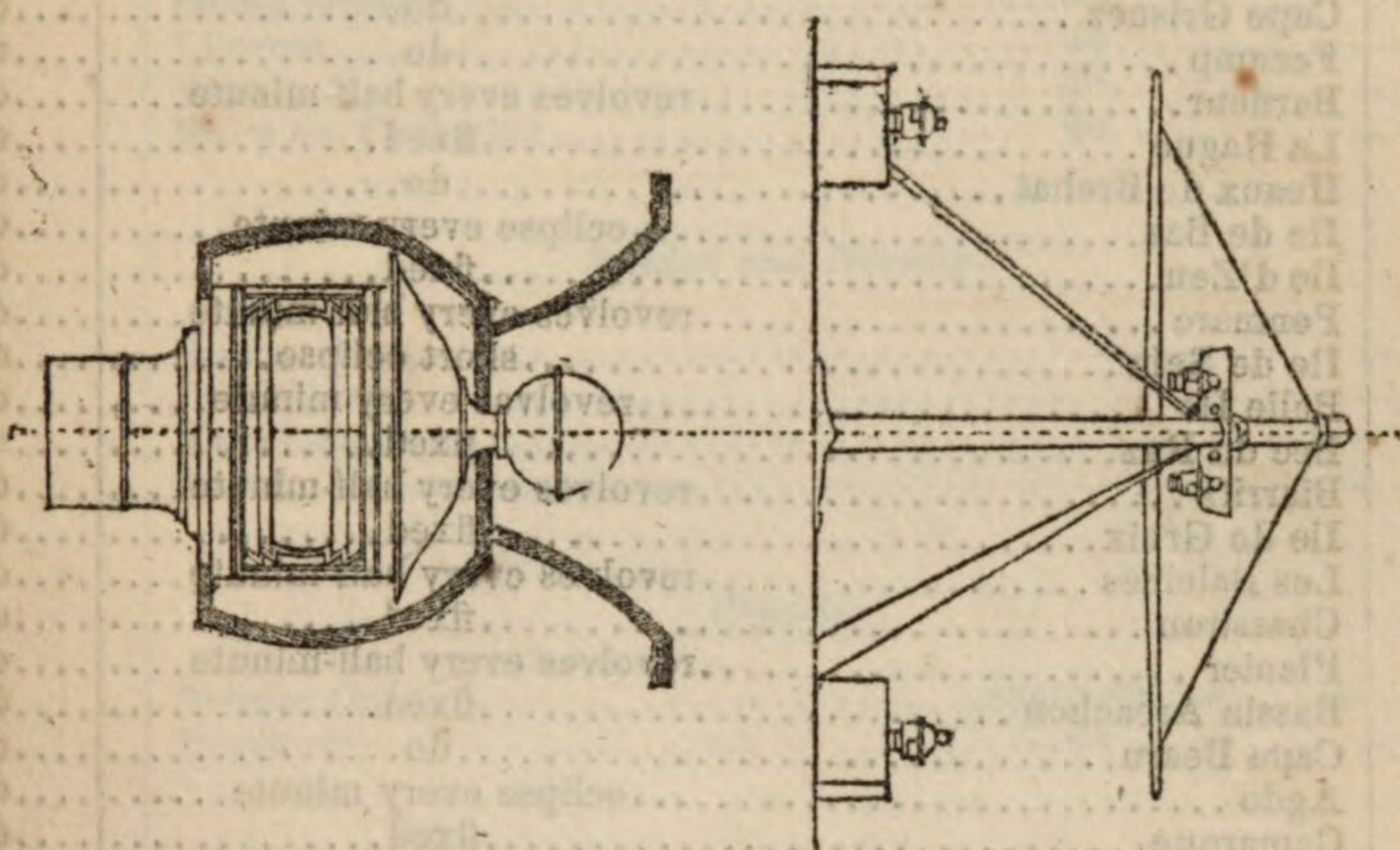


Fig. 2.



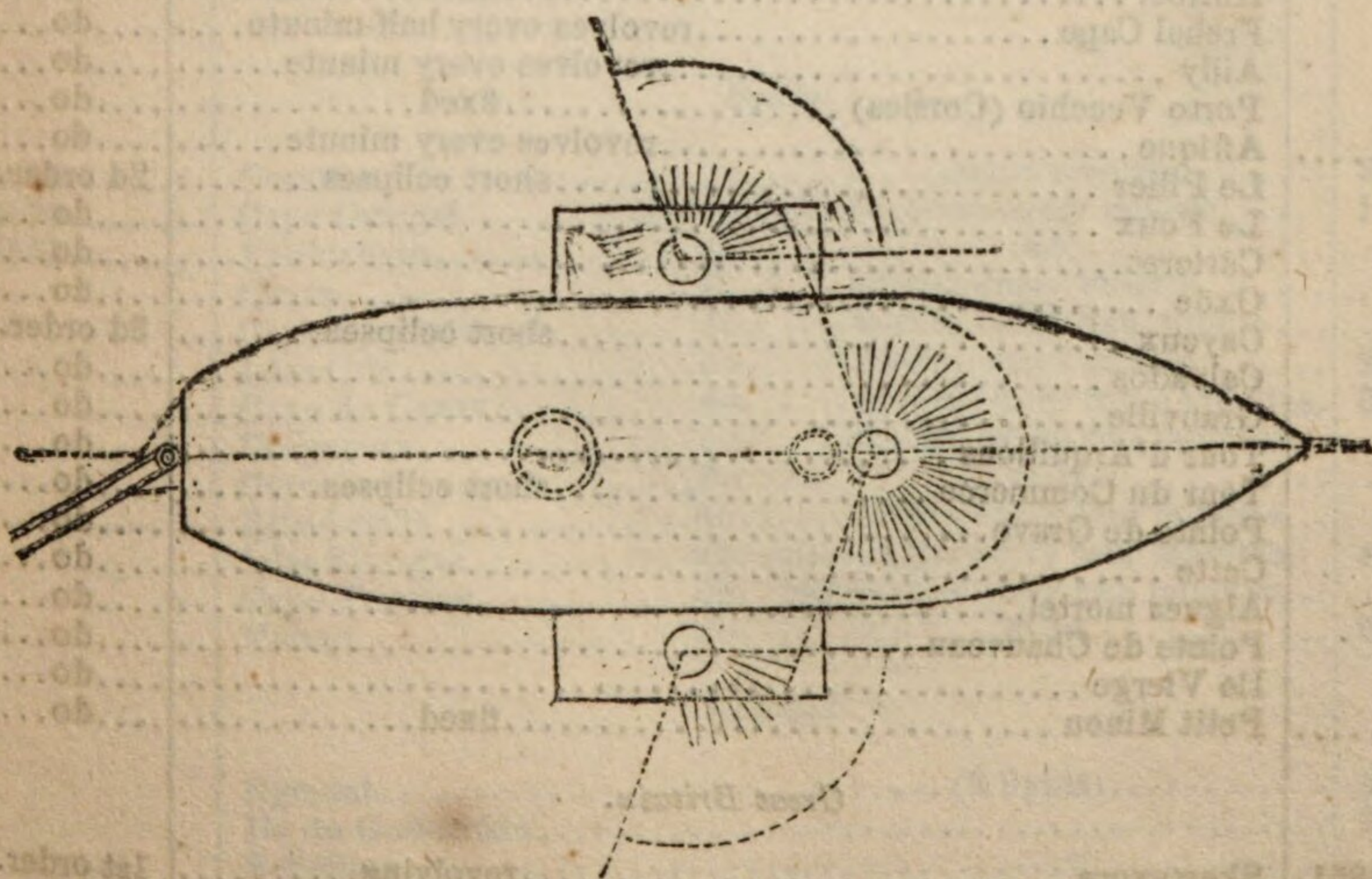
Suspension of a lantern and the indications of the position of the lights on board the steamer.

Fig. 3.



Mode of suspending the lantern forward.

Fig. 4.



A plan view of the positions geometrically traced, exhibiting the illuminated fields of the three lanterns.

List of the principal lights constructed in the establishment of M. M. Francois Soleil, Letourneau & Co., for France, Great Britain, Sweden, Norway, Prussia, Sardinia and Spain, upon the Fresnel system.

Date of construction.	Location and character of light.	Class.
<i>France.</i>		
1845 to 1851.	Dunkirque.....short eclipse.....	1st order.
	Calais.....fixed.....	do....
1846.....	La Canche.....do..(2 lights)....	do....
	La Hève.....do....do.....	do....
	Cape Grisnez.....do.....	do....
	Fecamp.....do.....	do....
	Barfleur.....revolves every half-minute....	do....
	La Hague.....fixed.....	do....
	Heaux de Brehat.....do.....	do....
	Ile de Bas.....eclipse every minute....	do....
	Ile d'Zeu.....fixed.....	do....
	Penmare.....revolves every half-minute....	do....
	Ile de Sein.....short eclipse.....	do....
	Belle Ile.....revolves every minute....	do....
	Bec du Raz.....fixed.....	do....
	Biarritz.....revolves every half-minute....	do....
	Ile de Groix.....fixed.....	do....
	Les Baleines.....revolves every half-minute....	do....
	Chassiron.....fixed.....	do....
	Planier.....revolves every half-minute....	do....
	Bassin Arcachon.....fixed.....	do....
	Cape Bearn.....do.....	do....
	Agde.....eclipse every minute....	do....
	Camarque.....fixed.....	do....
	Cordouan.....revolves every minute....	do....
	Porquerolles.....short eclipses.....	do....
	Camarat.....eclipse every minute....	do....
	Antibel.....fixed.....	do....
	Frehel Cape.....revolves every half-minute....	do....
	Ailly.....revolves every minute....	do....
	Porto Vecchio (Corsica).....fixed.....	do....
1848.....	Afrique.....revolves every minute....	do....
	Le Pilier.....short eclipses.....	2d order.
	Le Foux.....do.....	do....
	Carteret.....do.....	do....
	Oxœ.....do.....	do....
	Cayeux.....short eclipses.....	3d order.
	Calvados.....do.....	do....
	Granville.....do.....	do....
	Tour d'Arquillons.....do.....	do....
	Tour du Commerce.....short eclipses.....	do....
	Pointe de Grave.....do.....	do....
	Cette.....do.....	do....
	Aigues mortel.....do.....	do....
	Pointe de Chauveau.....do.....	do....
	Ile Vierge.....do.....	do....
1846.....	Petit Minou.....fixed.....	do....
<i>Great Britain.</i>		
1849 to 1851.	Skerryvore.....revolving.....	1st order.
	Cove sea Skerries.....do.....	do....
	Chanonry Point.....fixed.....	4th order.

H—No. 6—Continued.

Date of construction.	Location and character of light.	Class.
<i>Great Britain—Continued.</i>		
1849 to 1851.	Cromarty point.....fixed.....	4th order.
	Loch Ryan.....do.....	do....
	Ribble river.....do.. (2 lights)....	do....
	Adnamurchan.....do.....	1st order.
	Noss-head.....revolves every half-minute....	do....
	Start point.....do.....	do....
	Girdleness.....fixed.....	do....
	Pentland Skerries.....do.....	do....
	Island Glass.....do.....	do....
	Lismore.....do.....	do....
	Pladda.....do.....	do....
	Point St. Catharine.....do.....	do....
<i>Sweden and Norway.</i>		
	Gunnarsburg.....	2d order.
	Jomfruland.....	do....
	Munkholmen.....	4th order.
	Oxöe.....	2d order.
<i>Prussia.</i>		
	Bruster Orth.....short eclipses.....	2d order.
	Dorsseröth.....do.....	do....
<i>Sardinia.</i>		
	Ville franche (near Nice).....revolves every half-minute....	2d order.
	Tipo.....	3d order.
<i>Spain.</i>		
1846.....	Corunna.....short eclipses.....	3d order.
1850.....	Cape Ortegal.....catadioptric—revolves every minute....	1st order.
1851.....	Machichaio.....do.....do.....	do....
	Ceuta.....do.....flashes every minute....	do....
	Cape Finisterre.....do.....flashes every half-minute....	do....
	Islas Cris.....do.....flashes every minute....	2d order.
	Cape de Creux.....do.....flashes every three minutes....	3d order.
	Dragonera.....do.....flashes every two minutes....	do....
	Corrobedo.....do.....fixed.....	do....
	Ribadesella.....do.....flashes every four minutes....	do....
	Islas Sisargas.....do.. red flashes every four minutes....	4th order.
	Cape Priorino.....do.. red flashes every two minutes....	do....
	Mahon.....do.....fixed.....	6th order.
<i>Holland.</i>		
	Egmont.....(2 lights).....	3d order.
	Ile de Goderidde.....	2d order.
	Schelling.....	do....
	Ile d'Urk.....	4th order.
	Ile de Schouwen.....	1st order.

H—No. 6—Continued.

Date of construction.	Location and character of light.	Class.
	<i>Belgium.</i>	
1851.....	Ostende	3d order.
	<i>Cuba.</i>	
1848.....	Point de Maternillos flashes every minute.....	1st order.
1849.....	San Antonio flashes every half-minute..	2d order.
	Do.....	3d order.

H—No. 7.

*List of lens lights constructed in the manufactory of M. Henry Lepaute,
from December 31, 1845, to June 30, 1851.*

Date of construction.	Country.	Locality.	Orders.			
			1st.	2d.	3d.	4th.
1846.....	Norway.....	Wibrands.....				1
1848.....	do.....	Fieglehad.....			1	
1848.....	do.....	Tyrhong.....				1
1848.....	do.....	Terningen.....				1
1848.....	Sweden.....	Klostervarne.....			1	
1848.....	do.....	Ostergarne.....			1	
1846.....	Denmark.....	Korsøer.....				2
1851.....	do.....	Falster.....			1	
1846.....	Holland.....	Brouhershawen.....			1	
1846.....	do.....	do.....				1
1847.....	do.....	Batavia.....				1
1847.....	do.....	Flessingue.....				1
1847.....	do.....	Borselen.....				1
1847.....	do.....	Veere.....				1
1849.....	do.....	Scheveningue.....			1	
1850.....	do.....	Curacao.....			1	
1851.....	do.....	Harderwick.....			1	
1846.....	England.....	Corporation of Trinity House.....	2			
1846.....	do.....	do.....do.....				1
1847.....	do.....	do.....do.....				1
1848.....	do.....	do.....do.....		2		2
1849.....	do.....	do.....do.....	2			2
1849.....	do.....	do.....do.....		2		
1851.....	do.....	South Bishop.....	1			
1847.....	Cape of Good Hope.....	Cape des Aiguilles.....	1			
1847.....	do.....do.....	Cape Rescif.....	1			
1851.....	Spain.....	Cape de Peños.....	1			
1851.....	do.....	Cobregat.....		1		
1851.....	do.....	Galea.....			1	
1851.....	do.....	Castra Vidiales.....				1
1848.....	Philippines.....	Iles Mactan.....				1
1851.....	Sardinia.....	Porto Corres.....				1
1846.....	Two Sicilies.....	Nisita.....				1
1848.....	do.....	Procida.....				1
1851.....	do.....	Gaëte.....				2
1848.....	United States.....	Delaware.....			1	
1849.....	do.....	Nantucket.....		1		
1849.....	do.....	Carysfort.....	1			
1849.....	Austria.....	Cape Blanc (Dalmatia).....			1	
1850.....	do.....	Lagosta (Dalmatia).....	1			
1850.....	Brazil.....	Salinas.....			1	
1851.....	do.....	Mont St. Paul.....	1			
1846.....	France.....	Cape Frehel.....	1			
1846.....	do.....	Kermorvan.....			1	
1847.....	do.....	Benodet Concarnau.....				2
1850.....	do.....	Fatouville.....	1			
1850.....	do.....	Cape Sepet.....			1	2
1851.....	do.....	La Canche.....	1			
1849.....	Algiers.....	Arzew.....			1	
1848.....	do.....	Srigina.....				1
1851.....	do.....	Ailly.....	1			
1851.....	do.....	Baleines.....	1			
Number of lights constructed since 1849 by M. Henry Lepaute.....			16	6	16	28

H—No. 7—Continued.

RECAPITULATION.

Number of lights and beacons constructed in the manufactory of M. Henry Lepaute since December 31, 1845, up to June 30, 1845.

Lights of the first order.....	16
Lights of the second order.....	6
Lights of the third order.....	16
Beacons of the fourth class.....	28

HENRY LEPAUTE,
Constructor of Lens Lights, Rue St. Honorè, No. 247, Paris.

PARIS, July 28, 1851.

H—No. 8.

MARINE SURVEYOR'S OFFICE,
Liverpool, November 20, 1851.

SIR: I regret that my absence from Liverpool for a long period, in consequence of ill health, should have caused your letter from the light-house board of the United States, to remain so long unanswered.

Having only recently returned to my official duties, I now hasten to reply to the questions proposed in your communication of May last, which, I trust will be found satisfactory, and should further information, or explanation of any matter connected with the marine department at this port, be required by the light-house board of the United States, both the dock committee and myself will have much pleasure in furnishing it.

1. No change has been made in the mode and materials for light-houses at this port.

2. The best description of mortar for resisting the action of salt water, &c., is that composed of sand, lime, smithy ash; and the best coating for light towers, is paint made of pure white lead, with sand thrown on it, while the paint is in a liquid state.

3. No *Fresnel* lights have been introduced here. Parabolic reflectors of twenty-one inch diameter are in general use at the light-houses, with the exception of the two Hoylake light-houses, in which parabolas of twenty-nine and twenty-seven inches are used.

Refined olive oil has been introduced and burnt at the various light-houses and light-ships, instead of sperm oil. Since the year 1847, the saving in cost price, as compared with sperm oil, is about forty per cent.; and the illuminating powers are fully equal, if not superior, to those of sperm oil.

4. The best reflector in use is the parabolic. The proportion of silver used here is six ounces to the pound avoirdupois of copper. They are made of various prices and qualities, varying from two ounces to six ounces of silver to the pound of copper. Their illuminating powers and focal distance of lamp burner from reflector, are tested with those in use by means of the intensity of the light reflected by them.

5. Argand lamps are used in reflector shore lights.

6. The ventilation in the shore lights is effected by a chimney and turn-cap on the summit of the light-room or lantern; air valves in window frames and sides of light-room; and copper tubes over the lamp cylinders to carry off the smoke.

7. The materials of lanterns in the light-houses and sizes of glass vary considerably. In the Crosby light-house, (one of the last erected,) the lantern is of wood, lined with sheet iron; the window frames of iron; the panes of glass, of which there are three, are of the dimensions of six feet by three, glazed with putty and pins. The astragals are vertical, and although very strong, obstruct very little light. In the Rock light-house, built after the plan of the Eddystone light-house, the window frames and roof of lantern are of copper; there are sixteen squares of glass in the round, four ditto in depth; the squares are two feet five inches by two feet; the lantern is fifteen feet six inches in diameter; the astragals are vertical and horizontal.

8. The burners of the lamps are tipped with silver to prevent their too rapid decay from the action of the flame.

9. The best parabolic reflectors, after being twenty years in use with good care and attention, are not perceptibly deteriorated. The inferior quality are not used here.

10. A set of the best lamps, with silver-tipped burners, with good care and attention, will last twenty or thirty years, with occasional repairs and the renewal of the burners, which last on an average three or four years.

11. The repairs of illuminating apparatus are made under the direction and superintendence of the dock and marine surveyors.

12. The lamps and reflectors in the light-ships are not mounted on gimbals; but parabolic reflectors of 21 inches diameter, similar to those in the light-houses, are used in the light-ships, and lamps with a flat wick two inches wide; the oil cistern is placed at the back of the reflector, and the cistern is ingeniously subdivided by partitions perforated with holes, to prevent the flooding of the oil by the ship's motion. The introduction of these improved light-ships, lanterns, lamps, and reflectors, by which a light is produced equal to that shown from the light-houses, is due to Mr. Hartley, dock surveyor to the Liverpool dock trustees.

13. The greatest improvement made in the light-ship's moorings, is the introduction of wrought-iron welded studs in the chains, instead of the common cast-iron studs. These improved chains are used in the thirty fathom lengths next the bows of the light-vessels, and the chains have been found to break much less frequently than they did prior to their introduction. The remaining portion of the light-ship's moorings are of the ordinary stud-chain.

The buoy moorings vary in size, according to the dimensions of the buoys; the chains are made without any studs; the sinkers are of the shape and size shown in the accompanying drawing, No. 19.

14. The fog-signals in use at the light-houses and light-ships, consist of bells and gongs.

15. The material I should recommend for buoys, floating-beacons and light-vessels, is *iron*. The colors, shapes, distinguishing marks, &c., are shown on the chart of Liverpool bay, of which I send you a copy.

16. The buoys and light-ships are placed and moored in their positions by cross-marks and sextant angles; and a register is kept in the marine surveyor's office of every circumstance connected with them, according to form No. 1, sent herewith.

The light-ships' moorings are hove up and examined as far down as possible, on every favorable occasion; (see rule No. 14, "floating-light regulations;") they are entirely hove up, and the worn parts renewed annually. Duplicate light-vessels and buoys are kept ready for instant use. A buoy-tender manned by the shore party of the light-ships' crews, executes the buoy service, heaving up the moorings, &c.

The number of officers and men employed on board the light-ships, will be found in the light-ships' rules sent herewith, No. 17.

The masters of the light-ships are relieved every month; the seamen serve two months on board, and one month on shore.

For relieving shipwrecks, &c., the dock committee have established five life-boat stations in Liverpool bay, the rules and regulations for which (No. 14) I send herewith; also a copy of my report to the shipwreck committee, (No. 18) which contains all the information you require under this head.

The annual expense of this branch amounts on an average to £1,900.

Every branch of the marine department is inspected monthly, either by the marine surveyor or his assistant.

17. The appointments of light-keepers, &c., are made by the dock committee.

The instructions to the light-keepers are enclosed herewith, numbered from 7 to 13.

18. Iron-rod electrical conductors are employed.

19. The oils are tested by their specific gravity, burning, and the intensity of the light produced.

The chain moorings, both for buoys and light-ships, are tested at the corporation testing machine.

20. The system on which lights are masked at this port, is shown on the accompanying chart of Liverpool bay; the object being to point out to the mariner, by the opening and shutting of the lights, when he is to alter his course in the channel, or at the elbows of banks, &c. It also indicates the position of the Northwest and Crosby light-vessels, in the event of those vessels parting their moorings, and being absent from their stations. It may be effected by means of blinkers placed on the windows of old light-houses; and, in new ones, by the construction of the window frames.

21. The modes of distinguishing lights are *fixed, revolving, and flashing*; the colors are *red and white*.

The light-vessels show *one, two, or three* lights by night; and a large *ball* at the mainmast head by day; they are also distinguished by the color of their paint.

The light towers are painted *white, red and white, or black and white*; according to locality and back ground; the sea-marks are painted either *black, or white, or striped*; according to locality and back ground.

In renewing our correspondence, permit me to express to you the high sense I entertain of the favorable opinion and disinterested approbation which you were pleased to bestow on the marine establishment at this port; and allow me at the same time to congratulate you on the adoption, by the United States government, of the valuable recommendations and suggestions contained in the very able report of yourself and Lieutenant Bache, in 1846; and wishing you every success in the highly important and arduous duties that lie before you, I beg to subscribe myself,

With sincere esteem and respect, your obedient servant,

WM. LORD.

Lieut. THORNTON A. JENKINS,

Sec'y. U. S. Light-house Board, Washington.

List of documents sent herewith.

No. 1. Form of buoy register;

2. Notice to light-house visitors;

3. Light-ships' expense and demand-sheet;

4. Light-house monthly abstract;

5. Light-ships' " "

6. Return of Liverpool life-boats' services from 1840 to 1850;

7 to 13. Light-house rules and regulations;

14. Life-boats' " "

15. Specification for iron bell beacon;

16. " " iron light-ship;

17. Rules and regulations for floating lights ;
18. Report to shipwreck committee ;
19. Drawing of buoys, sinkers, &c.
20. " bell beacon ;
21. " iron light-ship ;
22. " showing the mode of construction ;
23. Notice respecting burning of blue lights at light-ship ;
24. Light-ship's store account book ;
25. Chart of Liverpool bay ;
26. Telegraphic vocabulary.

MARINE SURVEYOR'S OFFICE, LIVERPOOL,
November 20, 1851.

H.—No. 9.

MARINE SURVEYOR'S OFFICE,
Liverpool, October 16, 1843.

SIR: In compliance with the instructions of the sub-committee on shipwrecks, that I should report on the life-boat establishment of this port, and the extent and nature of the banks in Liverpool bay, I have to submit the accompanying statement :

There are nine life-boats stationed as follows, viz :

Liverpool -----	2	boats,	1	master,	and	10	men.
Magazines-----	2	"	1	"		10	"
Hoylake -----	2	"	1	"		12	"
Point of Air -----	2	"	1	"		10	"
Formby-----	1	"	1	"		12	"

Nearly all the boats have been built since 1839. They pull double-banked, are rigged with two sprit-sails and a jib, are of large size, possess great strength, and are constructed on the most approved principles, with air-tight casks inside, and a broad band of cork running round the whole length of the boat, above the water-line, to resist violent shocks and give increased buoyancy, enabling the boat to float, although loaded with a considerable number of persons, and filled with water, as many as fifty individuals having on one occasion been rescued from a wreck at one trip, making, with the boat's crew of eleven, sixty-one persons in the boat at one time.

The boats are kept on carriages in the boat-houses near the shore, and horses are provided to enable them to proceed to the most advantageous spot for launching. A gun is placed at the station to summon the crew, as also distance-flags at each light-house, light-ship and telegraph-station, for the same purpose, the arrangements in these respects being such, that in many instances the life-boat has been manned, launched, and on her way to the wreck in seventeen or eighteen minutes from the time of the distress-signal being seen.

The masters and crews of the Hoylake, Magazines, and Formby boats are composed of picked fishermen, intimately acquainted with the banks,

swashways, tides and currents in Liverpool bay. They reside in the immediate vicinity of their respective boat-houses.

The Liverpool boat's crew consists of experienced boatmen residing in the town.

The Point of Air boat's crew consists of two experienced Hoylake fishermen as master and mate of the boat. These men have been engaged for the last four years, at an increased annual salary, expressly for the purpose of organizing this boat's crew, and the rest of the crew are selected from the best and most expert men that can be found in the neighborhood.

The whole of the crews are kept in constant and permanent pay. They are regularly mustered and exercised once a month, and no expense has been spared in rendering the boats, their equipments, and crews, as perfect as possible.

The Hoylake boat is under the active and vigilant superintendence of Mr. Sherwood, revenue surveyor at Hoylake, the Point of Air boat under that of Mr. Dawson of Grovant, and the Formby boat under the direction of the keeper of the Crosby light-house.

The banks and dangers in Liverpool bay, may all be comprised within a triangle formed by the western patch of West Hoyle, the Rock light-house and Mad wharf—the former (West Hoyle) distant from Liverpool nineteen nautical miles, the latter (Mad wharf) twelve nautical miles; the cross distance between West Hoyle and Mad wharf being sixteen miles.

The principal banks are West Hoyle, East Hoyle, Great and Little Burbo, the Jordan flats, Burbo flats, Mad wharf, Mockbeggar wharf, Formby bank, and Taylor's bank. They are all remote from Liverpool, and many of them several miles distant from the nearest life-boat station—many patches of all the banks dry, and some of them to a considerable height above the low-water level; but in heavy, on-shore gales of wind, owing to the shallowness of the water, a continuous line of heavy breakers extends far to seaward on the weather side of them, rendering it extremely difficult, and at times perfectly impracticable, however advantageously the boats may be placed, and however near they may attain the position, to penetrate to a wreck so situated, without the certain and inevitable destruction of the life-boat and her crew. This has been strongly exemplified in the cases of the Athabasen and the Despatch, lost on West Hoyle. In both instances the life-boats reached the scene of the disaster, although four miles distant from Point of Air, and ten from Hoylake stations, but were obliged to abandon the crews to their fate, after repeated attempts to penetrate the line of breakers extending outside of them. Numerous instances of a similar nature might be adduced, occurring to vessels lost on the sandbanks on the east coast of England; one, in particular, recurs forcibly to my memory—that of the "Ogle Castle" Indiaman, lost on the Goodwin sands. In this case the Deal boats were so near as distinctly to see the successive surges sweep away the unfortunate crew from the deck and rigging, without being able to render the slightest assistance.

The remoteness of the banks from the land, and the long line of shoal water extending from them, renders the use of all projectiles, such as mortars, rockets, &c., inapplicable in Liverpool bay, as it very seldom happens that a wreck can be approached sufficiently near to render them available.

In face, however, of all the natural difficulties which Liverpool bay presents under these circumstances, and with the immense amount of shipping which enters and quits the port, it must be a gratifying fact for the com-

mittee to know, that for the last four and a half years only one call (that of the "Despatch" sloop, lost on West Hoyle) has occurred, in which the life-boats could not render assistance, owing to the circumstances above shown; whilst in the same period no less than seventy-four vessels have been assisted, and four hundred and fifteen lives preserved by their life-boat establishment, owing, no doubt, chiefly to the judicious position of the life-boat stations, by which one or other of the boats has always been able to reach the scene of the wreck; and lastly, to the perfect confidence the crews feel in their boats, and the praiseworthy exertions they have invariably shown in the performance of their duties.

To facilitate the operations of the life-boats, an arrangement is in existence with the steam-tug company, by which one of their steamers is to proceed out immediately the signal of distress is seen flying, taking in tow the first life-boat that reaches her, whether their own or one belonging to the Dock Trust, or both, if the weather will permit of it.

In order to point out and identify the exact spot to which the steamer or life-boats are to proceed, the whole of Liverpool bay and the coast, thence to Holyhead, has been divided into squares, numbered consecutively on the chart, each light-house, light-ship, and telegraph station, &c., being provided with such chart, and the keeper directed to report, by signal, the number of the square in which any wreck may occur.

I am, sir, your obedient servant,

WM. LORD.

To the Chairman of the

SUB-COMMITTEE ON SHIPWRECKS.

H.—No. 10.

Letter from Thomas Stevenson, F.R.S.E., F.R.S.S.A.

EDINBURGH, August 7, 1851.

SIR: In the absence of my brother, I beg to acknowledge thereceipt of your letter of the 27th May.

Having carefully perused the list of queries embraced in your communication, I beg leave to direct your attention to my brother's account of the Skerryvore light-house, and notes on light-house illumination published in 1848, and to his more recent publication entitled "A Rudimentary Treatise on Light-houses," &c., published by Mr. Weale, of London, in 1850. I think you will find answers, so far as they are known, to your queries in both of these books, but especially in the "Rudimentary Treatise." I may state the following, however, as they may not be so explicitly given in either treatise.

1. I am not aware that any of the slide lamps have ever been worn out.
2. Nothing has occurred to shake confidence in the concentric burner of Fresnel.
3. The same kind of oil is used in the northern light-houses, both in summer and winter.
4. The electrical conductors, which are of copper, are three-fourths of an inch in diameter, and tipped with platinum or palladium.
5. There is no difference in the number of light keepers for lens lights and catoptric lights.

6. No light keeper is allowed to leave the light room a moment before the arrival of his successor.

7. None of the northern light-houses have their characteristic distinctions altered.

I send you with this, three copies of a pamphlet just published, which contains the most *recent* improvements of which I am aware. These improvements constitute what I have called the Holophotal system of illumination, which, by transmitting *all* the divergent rays of a flame without unnecessary reflection or refraction in one parallel beam, thus gives out the maximum effect of the lamp. You will find a reference to this system at p. 142, part I, of my brother's treatise.

Although only very recently proposed, we have successfully introduced it at five different places, and another light is just about being got ready.

I remain, sir, your most obedient servant,

THOMAS STEVENSON.

Lieut. THORNTON A. JENKINS, U. S. N.,
Secretary to Light-house Board, Washington, D. C.

H.—No. 11.

Northern Lights.

LENS COMMITTEE, *February 23, 1833.*

Present, J. A. Maconochie, esq., James L. Amy, esq., Andrew Murray, esq., Archibald Bell, esq.

The convener laid before the meeting the following communication from Sir David Brewster, in regard to the comparative merits of lens and reflector lights.

"I take the liberty of addressing you as convener of the Light-house Committee, on the comparative value and economy of lenses and reflectors, and of suggesting some additional experiments for exhibiting the superiority of the former. I need not mention to you, that the most distinguished philosophers in the Institute, and the most celebrated engineers and naval officers in France, have, on the authority of direct experiments, decided in favor of lenses, both as to effect and economy.

"The academy of science of St. Petersburg have done the same more than five years ago, and Sir John Herschel has lately published the following testimony in their favor. The light-house, says he, with the capital improvements which the lenses of Brewster and Fresnel, and the elegant lamp of Lieut. Drummond, have conferred and promise yet to confer, by their wonderful powers, the one of producing the most intense light yet known, the others of conveying it undispersed to great distances. *Disc. on Nat. Phil.*, p. 56.

"The superiority of lenses, however, is no longer a matter of opinion, for it was proved, in the presence of the committee, that a single lens was equal to at least nine reflectors.

"This lens, too, was only twenty-nine inches in diameter, and was of green crown glass. Had it been made of good flint glass, and been thirty-six inches in diameter, it would have been equal to at least fourteen reflectors, four being added for the increase of area, which is a matter of simple

calculation, and one for the loss of light in the green glass. I shall not avail myself, however, of this undoubted fact, but shall take the result which was actually seen by the committee, namely, that one lens equals nine reflectors, and I shall apply it to the case of a revolving light.

"The revolving light with lenses will consist of two lenses placed opposite to each other, and illuminated by a single lamp between them. The revolving light with reflectors will consist of eighteen Argand burners, nine reflectors being substitutes for each lens.

"It being admitted that these two pieces of apparatus will give the same light, let us consider their comparative advantages :

"1st. The lens apparatus will be decidedly the cheapest in its first cost, and the lenses will never require to be renewed.

"2d. The lens apparatus will not require one-third of the labor in cleaning and arranging them daily for use.

"3d. The lens apparatus will not require so strong and powerful a piece of machinery to move it, from its inferior weight and its greater compactness.

"4th. The lens apparatus may be placed in a much smaller light-room, the eighteen reflectors requiring a very large space, and economy might thus be introduced in the erection of future light-houses.

"5th. The eighteen Argand burners will decidedly consume more oil than the simple compound burner used for the lenses ; hence it follows that the lens apparatus is in every respect better and more economical than the reflector apparatus.

"But in the above comparison I have omitted entirely the addition of the lateral lenses and mirrors which I proposed in 1811, and which were used in the French light-houses. These lenses and mirrors will enable us to take as much light from the compound burner (which otherwise goes to waste) as will be equal to four reflectors at the very least ; so that without the slightest additional expense, excepting the original cost of these small lenses, &c., we can give the lens apparatus a great superiority over the reflector apparatus.

"Let us now compare the lenses and reflectors in reference to the introduction of extraordinary illumination, which in fogs and in seasons of danger may be required.

"The means which may be thus resorted to are these : 1st, the Drummond light ; 2d, the blue and signal lights ; and 3d, any extra lamps which may be at the time in the light-house.

"In the lens apparatus the Drummond light can be introduced instantly, by merely putting the lime-ball in the place of the burner. In the reflector apparatus this is impossible. To produce the same effect the eighteen reflectors would require to be each fitted up with a Drummond light, the expense of which would be enormous, and for ordinary and extraordinary purposes the light-house would require in all thirty-six reflectors, to be as effective as the lens apparatus.

"In introducing the blue and red lights for occasional purposes, we have only to burn them on an iron plate or dish, placed either beside the burner or occupying its position. From the power of the red light to penetrate fogs, I consider it as an invaluable resource in light-houses. In the experiment which the commissioners witnessed, its brilliancy was fully equal to that of the lens apparatus. I need scarcely add that these signal lights cannot be introduced into reflectors.

"If the light-house keeper is provided neither with the Drummond light nor the blue and red signal fires, he can at present do nothing to add a ray to his reflectors, even if he knew that in a dark and stormy night human life is exposed to danger. With the lens apparatus, on the contrary, he can surround the main burner with all the spare Argand burners in his possession, and thus convey a great quantity of additional light into the refracted beam.

"Hence it follows that the lens apparatus is far more intense than a reflector apparatus of the same size; that with the same intensity of light it consumes much less oil; that in reference to original cost, repairs, and renewals, it is more economical; that it requires a less expensive light-room, and demands much less time and trouble from the keeper, while it possesses the property (which reflectors never can have) of admitting every variety of resource in cases which demand extraordinary illumination.

"I have no scruple in stating that the introduction of the lens apparatus will occasion an annual saving in the expenditure of the board; but if this were not the case, and if much more oil were consumed by the use of superior lights, it would still be the duty of the commissioners to adopt it. No mining company uses the old steam engines of Savary and Newcomens in order to save the additional expense of purchasing one of James Watt's. No astronomer continues to use the old refracting telescope because an achromatic telescope is a dearer instrument. In these cases scientific and pecuniary interests are alone concerned; but in the choice of lights, human life is involved, as well as national property, and a higher responsibility is therefore attached to their management. I trust, therefore, that the commissioners, now that they have witnessed the superiority of lenses, will not allow any considerations of economy (even if they did exist,) to prevent them from introducing a system of illumination already established in other countries, and calculated to promote the just objects for which their board was instituted.

"In order to prove more fully the value of lens illumination, I beg to suggest the following experiments and calculations:

"1. Try the Drummond light in the focus of the lens, and compare it with the same light in the focus of a reflector.

"2. Try the blue and red lights in the focus of the lens.

"3. Compare a single reflector with the same Argand burner in the focus of the lens.

"4. Compare the quantity of oil consumed by one compound burner with that consumed by eighteen Argand burners of the common size.

"5. Compare the expense of a light-house erected for a revolving lens apparatus, with that of one erected for eighteen reflectors.

"6. Compare the expense of two lenses (£25 each in Paris) with that of eighteen reflectors, adding the expense of their frames and of the machinery for moving them.

"Before concluding these hurried observations, permit me to add, that the use of distinguishing lights is considered by every person as highly desirable, and that it is only with the lens apparatus that they can successfully be introduced. I would beg leave, also, to repeat what I urged on a former occasion, that coal gas should be employed in every light-house where there is accommodation for its proper manufacture. An immense saving would thus be effected, and a more perfect system of illumination obtained.—

"ALLERLY BY MELROSE, *February 16, 1833.*

"J. A. MACONCHIE, Esq., &c., &c."

And the meeting being of opinion that the information contained in the above communication is of the greatest importance, in the view of introducing the apparatus into the light-houses in progress, direct the report of the engineer on the experiments already made and the above communication to be immediately reported to the Bellrock committee to ascertain whether it could not be done.

* * * * *

The difference between the original cost of the reflecting and refracting apparatus is of course more or less in proportion to the number of reflectors or lenses employed. The expense at Paris of the apparatus for the Tour de Corduan, where there are nine vertical lenses, besides a system of fixed mirrors, was stated by M. Fresnel to be about £1,500, but in estimating a similar apparatus, if again required, he made the amount 28,262 francs, or £1,177 11s. 8d. The cost of the reflecting and revolving apparatus with twenty-four reflectors is £1,387. "With regard to the annual expense and other conditions of the lens system, the engineer is not prepared to give an opinion; but after a sufficient number of trials have been made with the very complete apparatus provided by the board for investigating this important subject, he will be enabled to report satisfactorily upon the several objects to which his attention has been directed by the minute of the 23d February. In the meantime to meet the urgent desire of the Lord Provost of Edinburgh, the above estimate has been prepared from his notes, made with M. Fresnel when at Paris, and from his personal observations of the Tour de Corduan."

And on motion of the Lord Provost, it was resolved to recommend to a general meeting, to be called for the special purpose, on Monday next, at 12 o'clock, to have the light at Inchkeith immediately adapted to the lens apparatus.

The following communication was since received by Mr. Maconochie, from Sir David Brewster :

ALLERLY BY MELROSE,
March 29, 1833.

MY DEAR SIR : As the experiments made on the Calton hill afford sufficient data for guiding the opinion of the board, on the relative value and economy of lenses and reflectors, I beg you will submit to the commissioners, at their first meeting, the following statement, respecting some important questions, to which they will no doubt speedily direct their attention.

1. In establishing a new light-house, should the method of illumination by lenses be adopted ?

2. Would it be wise to dismantle every light-house in Scotland, and substitute lenses for reflectors ?

3. Should gas be introduced in place of oil ?

4. Should means be provided in every light-house for the occasional exhibition of powerful lights ?

5. Should a new system of distinguishing lights be matured and adopted ?

To all these questions I trust the commissioners will agree with me in giving an affirmative answer. That the committee of the Royal Society will concur in the statement I am about to make, I cannot for a moment doubt ; because scientific questions can admit of only one solution ; but if, like other prophets, our opinions shall have no weight in our own country, I shall, for the satisfaction of the board, be able to support them by the

concurring testimonies of the most distinguished professors in Cambridge and Oxford, and by the practical judgment of the most eminent scientific engineers of the present day.

1. In order to enable me to answer the first of the above questions relative to the introduction of lenses into new light-houses, I have obtained, from M. Fresnel, of Paris, a detailed estimate of the expense of fitting up a light-house with the lens apparatus, including all the necessary machinery and utensils, and on the scale which is in use at the magnificent establishment of Corduan.

The optical part consists of nine lenses, thirty inches in diameter; nine smaller lenses, with their reflectors, for widening the main beam of light; and another piece of apparatus for collecting the light that falls below the lenses. The expense of this part of the apparatus is 16,500 francs, or £687 10s.

The mechanical part consists of all the frame work and revolving apparatus, with three Carcel's lamps. The expense of this part, including the smaller utensils, is 9,500 francs, or £395 16s. 8d.; making the total amount 26,000 francs—or £1,083 6s. 8d.

Now, the expense of a reflecting apparatus with twenty-four reflectors, is £1,387, making a saving of £303 13s. 6d. in favor of the lenses, or of £413, reckoning £110 as the value of the plate glass cavall in the lantern for lenses. This saving will be increased to £513, because £100 may be saved by substituting an invention of Mr. Oldham's for the Carcel lamps, or by introducing gas.

If these twenty-four reflectors are arranged in groups of six, then the brightest light which at any one time reaches the eye, is that of six reflectors, which is repeated four times in each revolution; whereas in the lens apparatus we have a light equal to nine reflectors, repeated eight times during each revolution, besides the additional light of the eight smaller lenses, and that of the other piece of apparatus. Hence it is demonstrable that the lens apparatus is not only £413, or eventually £513 cheaper than the reflector apparatus, but gives a more intense and penetrating light.

But, independent of these enormous advantages, the lens apparatus is perennial, while the other is perishable, and requires to be renewed.

2. In answering the second question, respecting the propriety of dismantling every light-house in Scotland, and substituting lenses for reflectors, I shall treat the subject commercially, though I might at once solve the question, by affirming that if the lenses afford, as they have been proved to do, a more brilliant and penetrating light, they ought to be instantly adopted from motives of humanity, even if the board were to sustain a heavy loss. It is fortunate, however, that motives of economy and humanity are, in this case combined in favor of the change. In the following calculations I shall take a fixed light, such as that of the Isle of May, and a revolving light similar to that of the bell rock, and I shall suppose that the apparatus at both these stations is perfectly new.

The Isle of May light-house has twenty-seven reflectors; I propose to substitute, in place of them, a lens apparatus which will cost £1,000, the sum which is saved by there being no revolving machinery, being sufficient to purchase the additional lenses. Now the twenty-seven reflectors at present used will produce £567, and I estimate the value of the lamps, &c., at £50; so that the produce of the present apparatus will, at the very least, be £617, which, taken from £1,000, leaves £383 as the expense to

be incurred in establishing the new system of light, which will be at least six or eight times more intense than those now in use. This outlay, however, is nothing when we come to consider the annual saving.

The consumption of oil per annum at the Isle of May, is 1,080 gallons, which at six shillings per gallon, amounts to £324. But the lens apparatus requiring only one lamp, which consumes oil equal to fourteen Argand burners, (according to Mr. Stevenson) will burn only five hundred and sixty gallons of oil, which amounts to £168. Hence there will be an annual saving in oil alone of £156, besides £10 more for glass chimneys and other articles; this annual saving of £166 will surely justify the commissioners in making an outlay at the Isle of May of £383.

If we now take a revolving light of 24 reflectors, like that of the Bell Rock, the advantage of changing it for lenses will be equally clear. The expense of the largest and most complete lens apparatus for a revolving light, like that of Corduan, as already in detail, is £1,083. The value of the silver in the 24 reflectors will be £504, which, with £45 for lamps, &c., makes £594, leaving an outlay of only £434 in order to give the Bell Rock light-house a scientific and an efficient system of lights, which will be seen at a much greater distance than the present ones, and through a hazy atmosphere, which will completely obstruct the lights now in use.

But this change will also produce a great annual saving. Twenty-four reflectors consume 960 gallons of oil, which will cost £288; whereas the lens lamp will consume only 560 gallons, which will cost £168—so that there will be an annual saving in oil alone of £120 or £130, including a saving in glasses and other articles. In reference to the economy of light-houses furnished with lenses, I may state to the board, on the authority of M. Fresnel, the highly important and startling fact, that the annual expense of the great light-house of Corduan, including light-house-men's wages, oil, wicks, &c., is £395 6s.,* while the Bell Rock light-house costs the country £861 annually, on an average of four years, and the smaller one, at Tarbetness, £555 annually, on an average of three years.

3. I come now to the question of the substitution of gas for oil. In January, 1826, more than seven years ago, I urged the commissioners to make this great and obvious improvement; an improvement as valuable in point of economy as it is in reference to brilliancy of illumination. Experience, on a great scale, has already given its decision on this subject. Austria has, many years ago, lighted up with coal gas the great light-house of San Salvatore, on the coast of Istria, and the effect of the gas far surpasses that from oil lamps. The details of the relative expense of gas and oil have been published by Professor Aldine; but I shall trouble the board only with the grand result:

The annual expense of oil lights was-----	1,861 florins.
The annual expense of gas is-----	932 “

Making a saving of-----	929 “
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Exactly one-half of that of oil. If we include the interest on the money advanced for the gas apparatus, which was 400 florins, the total expense for gas annually is 1,332 florins, leaving still a saving of 529 florins, or nearly one-third of the expense of illumination by oil.

I may add, also, that two small light-houses at Dantzic are fitted up

* Less than \$1,800 per annum for Corduan light, fitted with a first order lens.

with gas. One of them consists of a parabolic reflector 22 inches in diameter, and the other of one 17 inches in diameter. Here, as in Istria, the introduction of gas has been found to be a measure of great economy, and the additional brilliancy of the lights at Dantzic was so great that the inhabitants of Hela, where the gas was first lighted, attributed the brilliant effect to a great fire in the city.

4. Seven years ago I suggested also the necessity of providing, in every light-house, the means of exhibiting powerful lights in cases of great emergency, and I have described, in my printed paper, the means by which this can be done. The Drummond light is obviously well adapted for this purpose, when placed in the focus of a lens,* but an equally efficacious and much cheaper substitute for occasional purposes has been suggested by Mr. Robison, namely: the burning of blue and red lights. I lately recommended the introduction of these lights into the focus of the lens; and the Board will recollect the splendid effect which was there produced by the red light—a light especially fitted for penetrating a hazy atmosphere. The use of such lights is impracticable with reflectors, and the facility and effect with which they can be used with lenses, is a new argument, if any were wanted, in favor of the latter.

5. During the late discussions in the House of Commons, Sir Edward Codrington pointed out the disadvantages to seamen of numerous light-houses; but these disadvantages exist only when the lights are not properly distinguished from one another. Hence it becomes a matter of the highest importance, especially when light-houses have become numerous, to establish a well matured system of distinguishing lights. The methods used in France do not afford a sufficient number of palpable distinctions. The use of colored media, or of transparent plates that produce periodical colors, or polarized tints, present us with the best means of supplying this desideratum. Experiments in which I have been long engaged, on the absorption of light by solid fluids and gases, have led me to various results, which are peculiarly applicable to the present purpose. I have in this way succeeded in impressing upon any given light a numerical character which no change can take from it, and which can be recognized by looking at the light through a small and cheap instrument made for the purpose. If the commissioners should desire to witness the effects of this and other methods of distinguishing lights, an apparatus could, with the assistance of Mr. Adie, be easily constructed. But if these new plans should not meet with the approbation of the board, the introduction of lens illumination will furnish ample means of obtaining distinguishing lights, by a well arranged succession of light and darkness.

Before concluding this letter, permit me to make a few remarks on the proposal to erect a lens apparatus at Inchkeith. As a light-house of the first order is not required at this station, it might, under ordinary circumstances, be sufficient to replace the present very inefficient apparatus by lenses of half the area and half the price (viz: £25 each) of the largest,

*I need not mention to any person acquainted with optics, that in the bungled experiments with the lens and Drummond light, on Thursday the 21st and Friday 22d March, the lens was so misplaced that the brilliant part of the column never reached the eyes of the spectators, who saw only the penumbra; otherwise, the Drummond light, with the lens, would have greatly exceeded that by the reflector. To prove this by ocular demonstration, the two lights, at a moderate distance, should be thrown into a room, and their radiative intensities actually measured.

and to employ only a burner of two wicks, which is equal to three and a half Argand burners.

This apparatus would consume only one fourth of the oil now used by the seven Argand burners, and would give a light several times more intense. Such an apparatus would cost about £500. But as I presume it to be the object of the board to erect one of the best lens apparatus, as a guide for their future proceedings, I earnestly recommend to them to have the apparatus complete, with all the modern improvements, and especially to light it with coal gas. The expense of the gas apparatus will be paid by its own savings in a few years, and that of the lens apparatus will not greatly exceed £1,000. But, whatever was its cost, it would be creditable to the metropolis of Scotland, and most useful to the navigation of the Frith of Forth, which is frequently beset with fogs, to have at Inchkeith a light-house of the first order in point of magnitude, and of the highest character in point of science.

I have, &c.,

D. BREWSTER.

To J. A. MACONCHIE, Esq.,
Convener of the Lens Committee.

*Extract from the Minutes of the Commissioners of northern light-houses,
 regarding lens apparatus.*

LENS COMMITTEE, *February 18, 1833.*

Present, J. A. Maconochie, esq., convener, James L. Amy, esq., Mr. Stevenson, and Mr. Russell.

The convener stated that he had convened this meeting with a view of having a report, by the engineer, on the experiments which had taken place in the lens light during the course of last week, and the same was laid before the meeting, and was of the following tenor:

“In reporting upon the experiments made before the committee on lens lights, on the nights of the 12th, 13th and 14th of February current, it may be proper to notice somewhat of the progress of the means employed for lighting the coast.

COAL LIGHTS.

“About the year 1786, when the northern light board was instituted, the public lights of the United Kingdom consisted generally of great coal fires, exposed in open chauffers, upon towers of masonry. This description of sea-light was so ill adapted to the purpose that, in stormy weather, while the leeward bars of the chauffer were melting with heat, the fire never kindled to windward, where, in such states of the weather, the light could alone be useful to the mariner. It may, however, be noticed, as a somewhat advantageous circumstance attendant on the open coal fire, that, in certain states of the atmosphere, its light is often reflected from the sky, to a distant observer, even when he cannot see the direct rays from the chauffer. This is familiar to every one who has seen the Carran iron-works, at night, from a distance.

REFLECTED LIGHTS.

“Upon the institution of the board of northern lights, its first object was to obtain every possible information regarding the existing modes of lighting the coast, a subject at that period but little known or attended to. It was accordingly resolved to adopt the use of oil with reflectors, instead of coal fires, and tallow candles then in use at the principal light-houses of the kingdom, as those of Eddystone and Scilly, and the lights of the friths of Forth and Clyde, &c., &c. The first used in the northern light-houses were formed to the parabolic curve, introduced and ingeniously constructed by the late Mr. Thomas Smith. The figure was given to these reflectors in plaster of paris, cast from a mould, made upon scientific principles, and the cavity was afterwards filled with small facets of mirror-glass, illuminated with a lamp of the common construction.

“In the year 1793 the reporter became connected with the light-house service, and in 1801 he was encouraged by the light-house board to make the entire tour of the southern coast, when, along with many other light-houses, he visited those of Eddystone and Scilly. From this tour the reporter trusts that he was enabled to introduce several improvements connected with his department in the northern light-houses. In the year 1803 the light of Inchkeith was exhibited, which was furnished with parabolic reflectors of silvered copper, raised as nearly as may be to the parabolic curve by a very nice process of successive turns of hammering to moulds prepared with mathematical correctness. The reflectors were illuminated by Argand burners and were, upon the whole, found greatly to surpass in effect the mirror-glass reflectors with the common lamp.

“It has always been a desirable object in lighting the coast to obtain a light which would more effectually penetrate a foggy atmosphere, and it has long since occurred to the reporter so to construct the reflector frame as to direct a few of the reflectors in each light room, that, like the open coal fire, their light might be thrown upon the sky and be reflected from thence to the eye of the spectator. But though this might be done, it would very rarely be useful to the mariner, while it would involve some practical difficulties which are not easily overcome. It is a curious and important fact that although a single reflector, as at Inchkeith, is found to exhibit a useful light to the distance of from eight to fifteen miles, according to the state of the atmosphere; and further, that although the Bell Rock light is distinctly seen even at the distance of thirty-five miles, when viewed from a sufficient elevation to compensate for the earth's curvature, yet the influence of these reflectors is not found to penetrate a foggy atmosphere so as to be serviceable to the mariner at a distance. To this object the reporter's investigations have long been directed, and on all occasions, in his official capacity, he has called the notice of the board to every improvement bearing upon that subject; on the other hand he has met with every possible encouragement from this honorable board to prosecute such inquiries to their full practical result, as will more particularly appear from what follows.

LENS LIGHTS.

“In the course of some observations made across the British channel between the heights of Dover and Calais, connected with the trigonome-

trical survey, Colonel Colly, with his usual friendship and marked attention to science, intimated to the reporter that a very powerful lamp and lens were used on the French side of the channel, (in the course of certain observations,) which he thought might be applicable to light-house purposes. Some time after, the reporter learned that Tour de Corduan, at the mouth of the Garonne, had been fitted up with lenses. In following up this subject in 1824, the reporter had the permission of the board to make a trip in the light-house tender along the coast of France. While at Paris, his desire of procuring this new apparatus was forwarded in the most handsome and liberal manner by Baron Becquey, director of the board of roads and bridges, and by the late eminent M. Fresnel, secretary of that board, under whose charge the light-houses of France are placed.

“When this powerful lens was brought to this country, it was suggested that by the substitution of flint-glass instead of crown-glass, of which material the Parisian lens are composed, the illuminating effect would be greatly increased. The board accepted of a proposition from Sir David Brewster to have one prepared, under his able direction, by Messrs. Gilbert, opticians of London. In order to ascertain the value of the lens light, compared with the present system of reflectors now in use, it became necessary to provide a suitable place for making a train of experiments. For this purpose temporary cabins have, by the permission of Mr. Fergusson, of Raith, been erected upon Gullan hill, on the coast of Huddingtonshire, which is distant about twelve miles in a direct line from Edinburgh. A committee of this board having been appointed to attend more particularly to this subject, the reporter is now able to state the result of three trials which have been made with these lenses and reflectors; and also to notice what is further proposed with regard to other experiments of a similar kind for improving the effect of the northern lights, especially in foggy weather. Agreeably to the arrangement of the committee, experiments with the French and English lenses were exhibited in separate cabins, situate about one hundred yards apart, and observed from the apartments obtained for this purpose at Carlton-place, Calton hill, which commands an open view of the cabins on Gullan hill, across the bays of Aberlady and Musselburgh.

First night's experiments.

“On Tuesday, the 12th February, current, the lens light was exhibited (viz: the French and English lenses in separate cabins,) from eight to ten in the evening. The atmosphere during this period was at times somewhat hazy, and the lights were occasionally almost obscured; but upon the whole they exhibited what, in the language of seamen, would be termed a fair and useful light at the distance of twelve miles. The atmosphere was clear with star-light in the heavens; but the lower part of the sky was obscured by haze, arising, perhaps, partly from an exhalation from the land, and partly from the smoke of the city.

“The light of Inchkeith, which is distant about five miles from Carlton-place, was also at times considerably obscured by these atmospheric changes, while the light of many, distant about twenty-five miles, was not at all visible.

“Sir David Brewster, who had been invited to attend these experiments in the early part of the day, accompanied by the reporter and Mr. Alan Stevenson, visited Gullan and inspected the arrangements made at that place

for exhibiting the lights. Sir David had also an opportunity of viewing the lights from Carlton-place, in the evening, with the committee of the board. Sir David then seemed to think that the English lens, consisting of flint glass, emitted more of the red rays than the French lens, consisting of crown glass, which, from its color or opacity, intercepted more of the red rays, which were necessary to the best effects of a light in hazy weather; but to an eye less accustomed to optical observations on the properties of light, the two lenses seemed to be pretty equal in their luminous appearance and effect.

"The experiment suggested by John Robison, esq., secretary to the Royal Society of Edinburgh, with the blue or Bengal light, was also exhibited; first at eight o'clock, but it was not then visible from Carlton-place. It was shown again at nine and ten o'clock, when it was faintly seen.

"There were present at these experiments Sir David Brewster, John Robison, esq., Thomas Guthrie Wright, esq., F. R. S. E. The members of the board present, were Mr. Bell, sheriff of Ayr; Mr. L. Amy of Forfar, and Mr. Maconochie of Orkney and Shetland, convener of the committee.

Second night's experiment.

"On the following night, as arranged by the committee, a light from the French lens, and a frame of nine reflectors upon the same vertical plane, were exhibited from eight to ten, the French lens being in the north cabin, and the reflectors in the southern cabin. On the suggestion of Sir David Brewster, the reflectors were lighted one after another every five minutes till the whole were lighted. In this state they were allowed to remain about thirty minutes, when the reflectors were again diminished from nine to one reflector, as at the commencement. In these proportions the spectators were enabled to form a comparative view between the refracted and reflected lights. The result of the experiment, in the judgment of the reporter, was that the lens light had a more brilliant appearance than the reflected light, till the number of reflectors were increased to about seven or eight, when both lights seemed equal to the naked eye; but when seen through the medium of a telescope, the lens light appeared to more advantage in point of brilliancy or intensity, while the body of the reflected light appeared larger to the naked eye.

"The night, upon the whole, was clear, though the effect of the lights was occasionally diminished by the varying state of the atmosphere. It however deserves notice that both lights seemed to be equally effective during the atmospheric changes alluded to. The same observations are applicable to the lights of Inchkeith and the Isle of May, as stated under last night's experiment.

"At ten o'clock, when the lens and reflected lights were extinguished, the Bengal, and also what are called red or crimson lights, were exhibited. The former was hardly visible, but the latter produced a bright flash of red colored light, which was distinctly recognized by the party.

"There were present on this occasion, Sir D. Brewster, Dr. D. B. Reid, Mr. Russell, lecturer upon natural philosophy; and Mr. Adie, optician. The members of the board present, were Mr. Bell, sheriff of Ayr; Mr. Murray, of Aberdeenshire; Mr. Bruce, of Argyle; Mr. Lumsden, of Sutherland; and Mr. Maconochie, of Orkney and Shetland.

Third night's experiment.

“On Thursday the 14th, the same experiments as on the 13th, were exhibited in a similar state of the atmosphere, and with as nearly as may be similar results. During the first half-hour both the lens and reflected lights were very indistinctly seen, but the atmosphere having become more clear, the progressive advance of the reflected light as compared with the lens light was quite perceptible, and both seemed equal when seven or eight reflectors were lighted on the frame. In this state they remained for about half an hour, when the reflectors were again diminished in number, and effects were produced similar to those produced last night.

“The experiments with the Bengal and red crimson lights were again exhibited. The former was hardly visible, but the latter, though of momentary duration, was distinctly seen.

“Inchkeith was somewhat more brilliant this evening than it was last night, the atmosphere in that direction being clearer. The May light was not visible. There were present this evening Lord Meadowbank, Sir Thos. Dick Sander, John Robison, esq., Allan Maconochie, esq., advocate, Dr. D. B. Reid and Mr. Adie, optician; and of the light-house board, Mr. Maconochie, sheriff of Orkney and Shetland.

“From the above detail, it appears that the English and French lenses exhibit much the same intensity of light. It was, however, Sir D. Brewster's opinion, that from the quality of the flint glass, which rendered it less liable to absent the red rays than the crown glass, it must be considered superior for the purposes of illumination. It was also Sir David's opinion, that if the English lens had been constructed with the same advantages of workmanship, its effects would have been decidedly better than that of the French lens.

“It also appears from the experiments with the lens and reflectors, that from seven to nine of the reflectors now in use at the northern lights, produce a light equal to that of the lens. It deserves notice that in this trial a powerful lamp is used for the lens, which consumes oil equal to the supply of fourteen Argand burners, but which, however, is capable of illuminating a system of lenses. It is further to be remarked that on a former occasion, in a very favorable state of the atmosphere, when the light at the Isle of May was seen from Carlton-place, the lenses afforded a much stronger and more powerful light than on any of the nights of the late experiments. The reporter regrets that he cannot at present name a night for the exhibition of the gas and lime-ball lights to be shown in connection with the lens and reflected lights, because, although the apparatus commissioned from Messrs. Troughton and Simms, of London, for this purpose, is complete to a certain extent, yet upon consulting with Dr. Reid, and making a preparatory experiment, it was found necessary to enlarge the gasometers. Of these, three of large dimensions have been made by his advice, and it is now expected that it will be practicable to maintain the gas light for two hours along with the other lights. This additional apparatus has already been under trial in Dr. Reid's laboratory in the college, where it has also been examined by Dr. Hope, and in eight or ten days the apparatus will be complete. Of this, notice will be given to the convener of this committee, that arrangements may be made for the attendance of the committee of the Royal Society, and of other gentlemen who may be invited to witness the experiments.

“Before reporting upon this additional train of experiments, the reporter expects to be able to state the respective elevations of the cabins on Gull-lan hill, and the rooms at Carlton-place above the mean level of the sea, and also their respective distances more precisely than his present information enables him to do. The reporter is further to lay before the board observations upon other parts of the subject, which he still intends to make with this apparatus, both in reference to the economy and efficiency of the northern light-houses.”

And the meeting expressed their satisfaction with the report, and directed a copy to be communicated to Sir David Brewster, and another to the secretary of the Royal Society for information of the committee, with whom the commissioners are co-operating.

H.—No. 12.

Letter from Messrs. Alexander Mitchel & Son.

BELMONT, QUEENSTOWN, CORK,
July 31, 1851.

DEAR SIR: We are in receipt of your favor of 26th May, with the interesting documents enclosed in it, and have much pleasure in replying to your inquiries respecting the screw-pile, being satisfied that the more extensively it is known the more extended will be its application. All the engineers of any standing in these countries have expressed themselves strongly in its favor; of these we may mention Messrs. Walker and Burgess, Rendal, Brunel, Cubitt, &c., &c., all of whom have adopted it in foundations where the ground was penetrable or covered by the water, and in every case it has proved eminently successful.

The screw-pile light-houses inspected by you and Lieut. Bache, when in this country, are all standing as you left them in perfect order, no repairs having been necessary, with the exception of paint; since then, some others have been erected by us. In the year 1849, we placed a screw-pile light-house in Dundalk bay for the commissioners of Irish lights; in 1850 we laid the foundation of a screw-pile light-house on the Chapman-sand, off Sheerness, for the corporation of the Trinity house, London, and we are at present constructing a screw-pile light-house on a shoal in Cork bay, for the Irish light-house board, all of which we hold to be a sufficient reply to whatever may have been urged against the system.

The Dundalk light-house stands on nine wrought-iron piles placed seventeen feet in the ground; it has been some time lighted, and is a great boon to that rising town. The Chapman sand light-house is also on nine wrought-iron piles placed thirty-nine feet in the ground, and the superstructure is now advancing under the management of the engineers of the Trinity house, Messrs. Walker & Burgess.

The construction of the Cork light-house, the foundation of which is now laid, has, with the exception of the lantern, been entrusted to us by the Irish light-house board, of all which works and others of still greater importance you will shortly have ample details, with drawings, from a small volume at present in the press, some copies of which we shall have much pleasure in forwarding to you; but probably the most severe test to which

these piles have been subjected may be seen in three beacons placed by us on the Kish, Blackwater and Arklow banks, dangerous shoals ten or twelve miles off the coast of Wicklow and Wickford.

Each beacon consists of a massive wrought-iron pile of great length, surmounted by a large ball; and although depending for support on a single screw at their base, they have all withstood the storms of several winters; but these beacons are not of themselves of much importance, having been placed principally for the purpose of pointing out the sites of future light-houses.

As to our screw-moorings, we have several persons constantly employed in putting them down, in the various bays and harbors of the United Kingdom; they being now preferred in these countries to all other moorings.

With regard to our light-houses, we have not found it necessary to make any material alteration either in their principle or form, although we have in the materials used, as we now prefer wrought iron and British oak, to the fir timber from the Baltic formerly employed. Wrought iron piles being in most cases especially necessary by reason of the various descriptions of sea-worm which everywhere infest our coast. Wood, however, is more economical, and may be safely used where the piles are occasionally open to inspection throughout their entire length, as in the case of the Fleetwood and Maplin sand light-houses.

The slight vibration occasionally observed, so far from detracting from their strength, really renders them more stable, in the same manner and for the same reason that springs have been found useful when applied to heavy wagons; sudden shocks being thus in both cases considerably softened and rendered comparatively harmless; of this the Small's light-house, now standing about sixty-years, is a remarkable example, which, together with the objections to cast-iron in sea foundations, and other matters interesting to engineers, you will find alluded to in the pamphlet which accompanies this letter.

Wooden piles when placed in fresh water, being free from the attack of worms, might (should economy be an object) be employed with advantage to support light-houses and beacons on the shoals of lakes and rivers. You say the chief objection urged by those opposed to screw-pile foundations are, too great vibration, excessive torsion, and in, some localities, not sufficient stability to withstand the force of the elements opposed to it. Of vibration we have spoken already, and hold that it is in no way injurious where not so great as to affect the light, and where the structure is placed on a base of sufficient breadth. If by torsion be meant the power employed in screwing in the piles, that can be rendered innoxious by giving to the screws the proper form, and to them and the piles strength sufficient to bear the twist; or, should a rotary vibration of the house be meant, this can be entirely prevented by the application of angle braces between the outer piles as shown in the Belfast and Fleetwood light-houses.

As to giving to such structures power to resist the elements, that must in every case depend on the judicious application of materials of sufficient strength, of not difficult solution, as shown in the success that has attended all our works. Some attempt has also been made in this country to lessen confidence in the screw-pile, by asserting that the Minot's Ledge light-house, destroyed last April, was placed on screw-piles; but this we understand to be a mistake, and would gladly have your authority for its contra-

diction. The accident was [possibly owing to screw-piles *not* having been used in the construction, or too insufficient breadth of base.

We shall also, at all times, be most happy to give you any information in our power on the subject of these works with which we may be connected; and should the presence of one of us tend in any degree to the more extensive adoption of the screw-pile or mooring in the United States, our junior is quite prepared to pay your country a visit.

It now only remains for us to express our high gratification at your appointment as secretary to this most important commission, and to subscribe ourselves with the highest respect,

Your obedient servants,

A. MITCHELL & SON.

THORNTON A. JENKINS, Esq.

H—No. 13.

GREAT GEORGE ST., WESTMINSTER,

August 1, 1850.

MY DEAR SIR: I have carefully examined the design for a landing pier at Osborne, in the Isle of Wight, which is, in my judgment, well suited to its purpose, as embracing lightness and elegance of appearance with great strength and firmness of construction, at the same time offering the least possible obstruction to the rise of the tide or stroke of a wave.

These advantages are obtained chiefly by the use of the patent screw piles of wrought iron, which are eminently adapted for the erection of structures of this kind, affording, as they do, a great facility of execution, and in matters of this kind especially, of which I may instance the pier for landing of passengers and goods, driven into the surf or swashing of the sea at Coustoun, in Ireland, in which (as probably it would in this case) the pier formed the staging for its own construction. I am very much in favor of the patent screw, having used it for very large moorings in the river Mersey, and my son, during the last year, built a large railway bridge in the fens of Lincolnshire, founded and supported entirely on screw-piles; and I believe they have been extensively used by Mr. Bendel for the construction of piers used in the erection of the great Portland breakwater. Nor can I conceive anything better adapted for a landing pier at Osborne, than a well framed platform of good timber, supported on piles of wrought iron screwed firmly into the bottom of the sea to the requisite and proper depth; and were I about to erect a pier, I should certainly adopt the same mode of proceeding.

I am, my dear sir, yours faithfully,

W. CUBETT.

To CHARLES MANBY, Esq.,

Secretary, Institution Civil Engineers, London.

NOTES.

During the summer of 1850, Mr. Mitchell laid down a screw-pile foundation for a light-house on the Chapman sands, near the mouth of the

Thames. These piles, nine in number and six inches in diameter, were screwed down forty feet, although the bottom is very hard ; but this depth was demanded by the contract. The heads of the piles were framed together, and the superstructure is to be completed by the engineer to the Trinity house, Mr. James Walker. Second, Mr. Mitchell has contracted with the Trinity house to put down a similar foundation for another light-house on the Goodwin sands. Third, the son of Mr. Mitchell was employed last December in erecting a screw-pile light-house at the entrance of Cork Harbor, for the Irish Ballast board. Fourth, Mr. Mitchell has been called upon for estimates to erect a screw-pile light-house at Singapore, and also for a viaduct many miles in length, to be constructed over the marshes in the province of Gararat (India) terminating in a screw-pile pier for shipping cotton wool, &c. Fifth, it is proposed to use 2,500 screw-piles on the Portland breakwater. These form a viaduct on which the cars loaded with stone from the quarries are made to travel by steam power. The stone is dumped off each car into the water, the piles being thus buried up in the operation. The great expedition and facility obtained by the use of this screw-pile viaduct or railway cannot be over estimated, as the train is loaded at the quarries and then rapidly drawn to the place of deposite, where the trap doors in the bottom of the cars are opened and the whole load discharged in a few minutes. This is one of the greatest works of modern days.

SCREW MOORINGS.

It is highly desirable that these useful moorings should be introduced for securing our buoys—the loss and repairs of which cost now annually \$20,000, owing to the insufficient moorings we now use in the shape of iron or stone blocks; a large number of buoys are swept away every year, or else dragged off into deep water or out of true position. The adoption of this mooring is general in Great Britain and the north of Europe.

H—No. 14.

RETURN OF TRINITY HOUSE, LONDON.

LIGHT-HOUSES AND LIGHT-VESSELS.

Extracts from reports of alterations and improvements.

1844.

“*The light-vessel near the Cork ledge, off Harwick harbor.*—This vessel exhibits a revolving bright light, shown by Argand lamps and parabolic reflectors, and was first exhibited on the evening of the 1st of May, 1844.” * * * *

“*Alterations.*—At the light-house on the Skerries rock, off the coast of Anglesea, the light was improved and strengthened by the substitution of a complete catadioptric apparatus for a fixed light of the first order, instead of the Argand lamps and reflectors previously in use thereat.” * *

“At the Point of Ayr, at the entrance of the river Dee, the light on the old tower was discontinued, and the exhibition of the light was thereafter made from a new light-house, erected on iron piles in the sand fifteen feet below the level of high-water, and at a distance of 2,500 feet NE. by N. from the old light-house.” * * *

“On board the St. Nicholas Gat light-vessel, in Yarmouth roads, the improved mode of exhibiting the light by the introduction of Argand lamps and parabolic reflectors was adopted, instead of the former less effective apparatus.”

1845.

“At the Eddystone light-house the lighting apparatus was altered by the substitution of a complete catadioptric apparatus for a fixed light of the second order, instead of the Argand lamps and parabolic reflectors previously in use thereat.” * * *

“The improved mode of exhibiting the lights on board of light-vessels, by the introduction of Argand lamps and reflectors, was adopted instead of the former less effective apparatus on board the light-vessel at the Newarp station, off the coast of Norfolk, and the light-vessel at the Mouse station, at the entrance of the Swin channel, off the coast of Essex.”

1847.

“*The light-house on Trevoze Head, county of Cornwall.*—This light-house exhibits two fixed bright lights, which are shown by improved catadioptric apparatus of the first order, and burn at the respective elevations of 204 feet and 129 feet above the level of high water, and were first exhibited on the evening of December 11, 1847.” * * *

“The use of refined vegetable oil, which had been adopted in lieu of spermaceti oil in the exhibition of the lights at several of the corporation light establishments, in the year 1846, was, during the year 1847, introduced for burning in all their light-houses and floating light-vessels.”

1848.

“*The light-vessel near the southeastern part of the Bahama bank, off Ramsay bay, Isle of Man.*—This vessel exhibits two fixed bright lights, shown by Argand lamps and parabolic reflectors, burning at the respective elevations of 38 feet and 20 feet above the surface of the water, and were first exhibited on the evening of the 1st of January, 1848.” * *

“*The light-vessels at the eastern end of Tongue land and western end of the Girdle land, in the Prince's channel, at the entrance of the river Thames.*—The former vessel exhibits two fixed lights, the upper being bright and the lower red: they burn at the respective elevations of 38 feet and 14 feet above the surface of the water. The latter vessel exhibits one revolving bright light, and both were first exhibited on the evening of the 1st October, 1848.” * * *

“At the Eddystone light-house a new lantern was constructed and fitted, the original lantern having been found unsuitable to the improved method of exhibiting the light by means of the catadioptric apparatus, which was fitted in 1845.” * * *

“At the Spurn low light-house the lighting apparatus was altered by the

substitution of a catadioptric arrangement for a fixed light of the fourth order, instead of the Argand lamps and parabolic reflectors previously in use thereat."

"In the course of this year an arrangement of colored lights was made, by the exhibition of which, at the tower of the high light-house at Harwick, and in Landguard fort, the navigation into Harwick harbor by night has been much facilitated."

"The improved mode of exhibiting the lights on board of light-vessels, by the introduction of Argand lamps and reflectors, was adopted instead of the former less effective apparatus on board of the Stanford light-vessel off the coast of Suffolk."

The following item occurs in the returns of expenses of the Trinity board:

1844.—Salary to the scientific adviser in light experiments and periodical and other reports from the civil engineer, £375.

1845.—For same as above, £305.

1847.—For same as above, and salary to the superintending working engineer, £552 10s.

1848.—For same as last year, £552 10s.

Extracts from reports of alterations and improvements of the light-houses on the coast of Scotland, (northern light-houses.)

1846.

"A new iron steamship has been built, of 303 tons burden, propelled by two engines of 150 horse-power, for the greater facility of conveying stores, &c., to the light-house stations, as well as for the beacon buoy service."

1847.

"*Girdleness.*—The upper light on Girdleness has been altered to the dioptric system, and the new light was exhibited on the 22d of September last. This work, which was of considerable difficulty and nicety in the execution, occupied no less than five months during the best season."

"*Dioptric apparatus.*—A considerable supply of dioptric instruments of various kinds has been provided from the works of Messrs. Letorneau, in Paris, and are now in store. These are to be applied as occasion requires, to the new light-houses and renovation of the old ones."

1848.

"The board came to the resolution, some years ago, of publishing in January, annually, a list of their light-houses, beacons and buoys. As the list of a succeeding year contained all the new lights or sea-marks of the preceding year, it is obvious that the lists of the preceding years are no longer accurate, and that it is very desirable that no such old and inaccurate list should fall into the hands of mariners. The board, therefore, at the end of each year, call in all the copies remaining unsold in the hands of the publishers, which, after being defaced, are sold as waste paper." * * *

"Against which deficiency, however, there is to be placed £12,565, the

value of dioptric apparatus already reported as being in store, so far as not required in 1849, and which will be used in future years as occasion shall arise, either in replacing reflecting lights or in constructing *new* light-houses." * * * *

"The committee have to remind the board, that even were the whole of the above light-houses completed, they form but a portion of the board's great objects, namely, to light up the whole seacoast of Scotland, so that vessels approaching it from any quarter, as soon as they lose the guidance of one light may come under the direction of another, and also to establish a sufficient number of minor lights as guides to the principal bays, sounds and harbors of refuge." * * * *

"The last year's expenditure includes, besides the ordinary maintenance, the expense (not likely to occur to the same extent in future years) of furnishing a complete set of duplicate buoys, renewing Campbeltown beacons, and erecting store-yards; but still the annual expense of maintenance must, in future, rise with the increase of sea-marks which have to be maintained. Indeed, it has been estimated that on the completion of the system, their maintenance will require between £3,000 and £4,000 per annum." *

Among the expenses incurred by the northern light-house board, is that of 'training expectant light-keepers;' being their travelling charges and subsistence, £68 17s. 9d. or about \$330.

"*Pentland Skerries*.—The change of the two lights at this station from the parabolic reflectors to the dioptric system, and the consequent erection of dwelling-houses for the two additional light-keepers called for by the change of the light, have been completed, and the improved lights, on the 20th September last. The additional light-keepers have also entered on their duties and taken possession of the new dwelling-houses." * * *

"A light-room for the purpose of constructing experimental exhibitions of lights has been erected at Inchkeith, from the materials of the old lantern at Girdleness." * * *

"*Dioptric apparatus*.—The order of the board for procuring and laying in store a quantity of dioptric apparatus, to be used as occasion required in the renewal of old reflecting lights, or in the construction of new light-houses resolved to be built, has now been completed." * * *

"The board has thus erected twenty-seven great sea-lights on the coast of Scotland, including three on the Isle of Man, but exclusive of three secondary lights, besides rebuilding three of those which were first erected."

"The lights in the course of erection as well as those resolved upon, are all noticed in the summary report as being required in the precise localities selected by the board, thus affording a confirmation of the views which the board entertain, and as a testimony to their judicious choice of stations."

"When the works now mentioned as in progress have been completed, the light will in only two instances be more than fifty miles apart, and the great majority will be much nearer each other. The exceptions alluded to will be between Cape Wrath and Island Glass, (about 70 miles,) and between Cape Wrath and Kyleakin, (about 84 miles.)"

"In conclusion the committee may observe, that while they concur in the utility of various lights suggested in the summary reports, not only those lights, but many others have been under the consideration of the board. Their final object, in so far as the funds at their disposal will permit, is to light up the whole seacoast of Scotland, so that vessels approaching it from any quarter, as soon as they lose the guidance of one light may come under the

direction of another, and also to establish a sufficient number of minor lights as guides to the principal bays, sounds and harbors of refuge.

"These purposes have been in a great manner accomplished in what appears to the board to be a proper mode, by first establishing those lights which were of primary necessity, and afterwards proceeding to those not indispensable, although highly expedient for completing the system of lights.

"But the board will not consider their duty fulfilled until the final object now announced has been fully attained."

Extract from the bye-laws of the Board of Northern Lights.

Each light-house shall be under the charge of a committee of three members of the board, of which the sheriff of the county in which each light-house is situated shall always be convened, and such committee shall audit the annual requisition for ordinary maintainings and usual repairs, and shall report to the standing committee, or to the general meetings, anything requiring their attention.

As soon as the board shall resolve upon the erection of any new light-house, a remit shall be made to the Bell Rock committee, and they shall name a committee, consisting of not less than three members, to whom shall be submitted, in the first place, all matters connected with such new light-houses, but subject to the approbation of the Bell Rock committee.

The board of northern light-houses was divided into seventy-two committees in 1844, each committee being charged with certain important specific duties connected with lights, buoys, beacons, keepers, &c., &c.

Average number of annual meetings of the commissioners of northern light-houses from 1837 to 1850 inclusive, 53.

Average annual number of folios to which their minutes extend, for the same period of time, 1837 to 1850, 505.

Average annual number of letters despatched from the secretary's office for the same period of time, 1837 to 1850, 3,223.

Average annual number of letters despatched from the engineer's office for the same period of time, 1837 to 1850, 1975.

H—No. 15.

LENS LIGHTS.

Extract from a communication from Mr. Herbert, Secretary to the Trinity Board, to Mr. Cunningham, Secretary to the Commissioners of Northern-lights.

TRINITY HOUSE, LONDON,
February 21, 1844.

* * * * Although the catadioptric principle for light-house illumination has in several instances been adopted by the commissioners, (of northern lights,) the elder brethren are desirous to draw their attention to the economical advantages which it possesses in certain cases, as affording

ground for its more extensive use whenever proper occasions for its application may present themselves. * * * *

Under this consideration the elder brethren would recommend that the periods of illumination and eclipse might preferably be made equal. They deem it also proper to remark, that, in observing the effect of the twenty-five-inch reflectors in use at the Pentland Skerries, the committee found the period of diminution of light, when between the focal lines of two of those reflectors, much longer than when between the same lines of two reflectors of twenty-one-inch diameter.

Extract from the report of the committee of the Royal Society of Edinburgh, appointed to co-operate with the Commissioners of Northern Lights, in 1836, Professor Forbes, reporter.

The committee were requested to compare the new fixed dioptric light on the Isle of May, distant thirteen miles, with the old catoptric light placed on a temporary erection near it. After detailing the different appearances of the two lights, &c., in the body of the report, they say—

The following conclusions seem to be warranted :

1. That at a distance of thirteen miles, the mean effect of the new light is very much superior to the mean effect of the old light, (perhaps in the ratio of two to one.)

2. That at all distances the new light has a prodigious superiority to the old, from the equality of its effects in all azimuths.

3. That the new light fulfils rigorously the conditions required for the distribution of light to the greatest advantage.

4. That at distances much exceeding thirteen miles, the new light must still be a very effective one, though to what extent the committee have not observed. The light is understood to be still a good one when seen from Edinburgh, at a distance of about thirty miles.

GREENOCH, *Vice President R. S., Edinburgh.*

JNO. ROBISON, *Secretary R. S., Edinburgh.*

THOS. STEWART TRAIL,

R. CHRISTISON,

JAS. D. FORBES, *Reporter.*

The catoptric light, at the time of this comparison, was fitted with twenty-two large parabolic reflectors.

For Mr. Stevenson's opinions upon the subjects connected with dioptric lights, mechanical lamps, &c., reference may be had to his reports bearing date December 10, 1834, Edinburgh; October 27 and November 25, 1835; October, 1836; December 10, 1839, &c.; and also his evidence before the select committee of the House of Commons, 1845.

Extracts from the bye-laws of the Commissioners of Northern Lights.

The duties of the engineer, generally, shall be—

1. To make all surveys connected with the light-house service in every department, either with a view to the erection of new light-houses, beacons

or other works, placing of new buoys, or the execution of repairs or alterations of the existing establishments.

2. To make and execute the designs of new works, to furnish the requisite plans and specifications, and superintend their erection.

3. To ascertain and cause to be executed the required improvements and repairs on the light-houses already erected.

4. To prepare for the consideration of the commissioners, the report of the principal alterations and improvements, (if any,) which is directed annually to be laid before Parliament. This is to be laid before the commissioners one month previous to its presentation to Parliament.

5. To provide the estimated stores for the use of light-houses, which is done by sealed tenders, as far as practicable, and to distribute these to the different stations.

6. To regulate and superintend the light-house establishments at the different stations.

7. To superintend the shipping department.

8. To conduct the correspondence with the different light-house establishments, to call in all the accounts incurred in the department, examine them, compare them with the orders given, certify them, to try the calculations and check them, as also to allocate them to the branch of service to which they belong.

9. To keep the requisite books and accounts of the distribution of stores, so as to show the expense of maintaining each establishment.

10. To keep a register of all the harbor lights on the coast, and of any changes made in their character and position.

11. To visit all the light-houses once every year and in the month of January, annually, to report their state during the past year, and their requirements for the ensuing year, to the commissioners.

12. To submit to the board the names of applicants to fill all inferior stations in his department, or in the shipping department, along with the names of the candidates; their respective certificates and testimonials shall be laid before the board.

13. All light-keepers are in the department and under the superintendence of the engineer, who is responsible for their observance of the rules and instructions from time to time issued for their direction; and also for their general good conduct.

14. In case of neglect, disobedience, or other serious fault, the engineer has power to suspend any light-keeper or other officer in this department; but he shall forthwith report all such cases to the commissioners, by whom they shall be considered, and the offending party subjected to dismissal or such punishment as the offence may merit.

Note.—To enable the engineer to discharge his duties, he is allowed the assistance of the officers previously named in his department; and though their duties are hereinafter specified, it is not thereby intended to limit their duties, but they shall act under the orders of the engineer in any other matters from time to time required of them.

The engineer is also allowed an annual sum to provide such further assistance as he may from time to time find to be requisite for the efficient discharge of his duties.

Extracts from the evidence of Mr. Alan Stevenson, Engineer to the Commissioners of Northern Lights, before the select committee of the House of Commons, 1845.

Will you explain the kind of burner you use? The dioptric burner, consisting of four concentric wicks, one wick within the other.

That is the French burner? Yes, the flame was nearly four inches in diameter and about the same in height, or rather more now; it is now nearly five inches high.

You call that one burner? Yes; we call that one dioptric burner.

And one of these is equal to seventeen Argand burners? Yes; seventeen of the burners used for a reflector.

Was it not formerly estimated at fourteen as the proportion? From fourteen to fifteen.

But you find from experience that seventeen is the average? Seventeen is the average if the flame be kept at its best or normal height.

Does that new glass applied to it increase the combustion? It increases the combustion and renders it more perfect. Another improvement is the adoption of the ventilating tube, by Dr. Faraday, which I find of advantage in the dioptric apparatus; it causes a more perfect combustion and raises the flame.

Has that been adopted in all your light-houses? It has in all the dioptric lights.

You state that there are twenty-seven reflectors at the Pentland Skerries: supposing that light-house were changed to a dioptric light, what difference would it make in the consumption of oil, and in the expense generally? I reported upon that subject to the board. That report at the same time notices a defect which is common to all fixed apparatus upon the catoptric principle. * * * * In the line of the axis the light is the strongest; it gradually diminishes as you approach the sides, until you come to that part which is called by opticians the penumbra, where it is extremely feeble. * * * * The saving of expense by the change referred to would be ten-twenty-sevenths of the whole.

Have you those reflectors in general use in Scotland? Yes; the lamp is placed in a position like this black mark upon the drawing, and about twelve-twenty-sevenths of the whole light falls upon the surface of the reflectors, and is projected in a direction parallel to this centre line, which is called the axis of the mirror.

Then are five-twenty-sevenths lost? Yes.

What have you upon the Skerryvore? In the Skerryvore the light is revolving.

Is it a French one? Yes; a dioptric one, with inclined lenses above, and a set of lower zones not yet added.

What is the nature of that apparatus upon the table? This model represents a lens used in a revolving light, such as Skerryvore. To prevent the loss of light above and below this principal lens, which in some measure answers the same purpose *mutatis mutandis* as the equatorial band of fixed light, an arrangement of a peculiar kind is adopted. It consists of eight smaller lenses, inclined to the horizon at 50° , and forming by their union a frustrum of an octagonal pyramid. The light falling upon the inner surface of these lenses is collected into parallel beams, inclined to the horizon at 50° , and above this are placed eight plane mirrors, whose action

is to *reflect* these beams which have already been *refracted* by the small lenses, so as to throw them in directions parallel to the horizon, and thus to assist the action of the principal lenses. In this way the light which escapes above the lenses is turned to a useful purpose. This is the arrangement, with some few improvements, which was first adopted in 1823 or 1824 at the Cordouan light-house, by M. Fresnel.

Do you not consider that much light is saved by that plan? A considerable portion. There is not, however, more than eight-tenths obtained in this way from that revolving apparatus, while in the fixed apparatus there are fully nine-tenths of the whole light.

If you had put up at Skerryvore, instead of the dioptric light, the old lamps and reflectors, which would have been the cheapest, in point of annual expenditure? I hold that one of these lenses is equal to at least ten reflectors.

Which is the most reasonable in point of annual expenditure? That would depend upon the number of reflectors employed to obtain a light of equal power.

Suppose you put thirty reflectors in the one, and instead of thirty reflectors you put a dioptric light, which would be maintained at the lowest annual expenditure? The French apparatus would be the cheapest in point of oil; it would be in the proportion of seventeen to thirty.

Then what would be the ratio in point of expense: suppose one to be a thousand, what would be the diminution of that by adopting the dioptric light? The result would be in the proportion of seventeen to thirty or 566.66 to 1000.

Nearly one-half the expense would be saved? Yes; a little less.

Do you consider the light-houses at present in Scotland all provided with the best improvements which you can introduce? I think they are. I would recommend the substitution of the dioptric apparatus in several cases to fixed lights in particular. The small apparatus is advantageous in fixed lights, but not in the revolving lights.

Do you contemplate any further improvements, or are any experiments going on which promise any improvement? No. I conceive the chief direction in which improvement is to be sought, is in regard to the nature of the flame itself, and not in regard to the apparatus which modifies the light, which I think is perfect.

What do you mean by the nature of the flame? Do you mean gas? If we had a flame which had the property of being more intense, larger in volume, and at the same time cheap, a very great improvement would be effected; but I do not myself know in what direction to seek for such a change.

Have you made any experiments with gas or with camphine, which has been lately introduced? No; I have tried some other substances. I have tried the vapor of naphtha.

In any of them have you found a superior flame? I have found nothing that I conceive warrants the running any risk in regard to the regular exhibition of the lights, which is more or less involved in the use of gaseous substances.

Then, since the inquiry in 1834, has there in fact been much improvement made in the mode of illuminating? The only practical improvements of which I am aware are those I have already described—the changes in the form of the dioptric fixed apparatus, and in the addition of the totally

reflecting zones; also, in the changes in the form of the chimney, and the addition of Dr. Faraday's ventilating tubes. There are besides some less important changes in the arrangement of the apparatus, which tend to economize the light. * * * * The object in a light-house is not to get a very high flame, but a wide and steady flame—a flame that does not change its contour, but burns steadily.

Have you burnt a lamp with five wicks instead of four? Yes.

What has been the result of that? The result has been a greatly increased volume of flame, which is a great object in increasing the duration of the flashes in a revolving light, but it produces a great increase in the expenditure of oil, to the extent I should say of one-third.

You were examined in 1834 respecting the state of the light-houses in France; can you state if any, and what improvements have taken place since then? I am in constant correspondence with M. Fresnel, the engineer of French light-houses, and all the improvements which we have adopted, have been adopted in France, while on the other hand, we in Scotland have all the latest improvements in France.

Now with regard to training: Do you place the light-house keepers under any particular training? They are required to reside six weeks at the Bell Rock, and six weeks at either Inchkeith or the Isle of May, so as to see both a dioptric light and a reflecting light.

Have you made any calculation of what the expense would be of sending the oil and other stores required at the light-houses, by public conveyance, if these tenders were not in use? No, I have not.

Do you believe that any saving would arise from that? I am inclined to think not; the loss of time would be considerable, in making arrangements.

And a liability of damage to the stores? Yes.

Have these vessels ever been required unexpectedly for any particular duty, or do they merely take the routine at the proper seasons of supplying the stores? They are frequently required to go on a short notice, in case of anything occurring. One very common emergency is the breaking of the panes of glass in the lantern. I have known instances where more than half the panes in the lantern were blown in by a gale of wind.

What kind of glass do you use? Very strong plate glass; a quarter of an inch thick.

And that has been blown in? Yes, it has on two occasions within my recollection, at Dannethead; and sometimes sea-fowl have come through.

Then, in your opinion, that department could not be more economically conducted than it is now? No, I think not; not certainly by trading vessels.

H—No. 16.

Extracts from Parliamentary report of 1845.

COLZA OR RAPESEED OIL.

* * * * *

“It is to be observed that for many years the French have used for their lights, colza or rapeseed oil, which costs about 3s. 8d. a gallon, whilst in

England the best sperm oil is used, which costs from 3s. to 8s. per gallon; the price of oil alone must make a considerable difference in the expense of maintenance.

“Mr. Wilkins, of Long Acre, a light-house lamp manufacturer, has invented a lamp of peculiar construction, in which he burns rapeseed oil, and he has offered to supply and maintain a light-house of fifteen burners, providing lamps, oil, and everything necessary to maintain the light, exclusive of wages and furniture for the light-house, at the rate of £151 9s. for twelve months. He says that half the expense of the oil for lights would be saved by using the rapeseed oil. But it will be seen that Mr. Halpin states that about one-sixth more of rapeseed oil than sperm oil is consumed in the same time, and that in his opinion the saving will not be so much. Mr. Wilkins states, in proof of his opinion, that he has for some years past supplied rapeseed oil to several lights abroad; the light at Dover, the Tees navigation lights, the light at the Nore, and at other places, where the rapeseed oil has given a brilliant light, and is spoken of confidently, as likely to afford a great saving.

“Your committee consider that, after such experience, the public lights in this country may safely be tried with that oil, with the view of economy. By reference to the appendix, for an example, it appears that the whole ordinary expense of the Flamborough light was £701, in the year 1843, and of that sum £303 was for oil. The Dungeness light cost £532 for ordinary maintenance, and the oil cost £229 of that sum. But the comparison of aggregate expense, when applied to any other charges than the mere expense of oil and lighting stores, is fallacious, because establishment of keepers and other expenses must be the same, whether the number of burners be the more or less; and Mr. Herbert states that there is no certain standard of comparison applicable to any other charges there. At Wakefield, for example, one burner is kept, but the servants to attend to it, viz; a principal and assistant, are as many as at Beachy Head, where there are thirty burners.” * * * *

IRON SCREW-PILE LIGHT-HOUSE TOWERS.

“The attention of your committee has been called to the erection of fixed light-houses, where floating lights are now maintained, and to the substitution of iron for stone and brick houses, and there is reason to believe that a considerable reduction of expense in the light department may be effected by the adoption, in part, of these improvements. Your committee directs particular attention to the evidence of Mr. Alexander Mitchell, civil engineer, whose invention of the screw-pile, the efficiency of which has been tested for some time, in one or two places, recommends itself as affording the means of substituting, in some places, fixed for floating lights, whereby the double advantage of increased security and efficiency of light, and a saving of expense, both as regards construction and maintenance, may be obtained.

“For details, your committee refers to the evidence of Mr. Mitchell, and to the appendix.”

APPENDIX TO PARLIAMENTARY REPORT OF 1845.

Instructions to light-keepers in the use of barometers, &c.

By the corporation of Trinity house of Deptford Strond. Instructions to the light-keepers in the use of barometers and thermometers, and in recording their observations.

1. Four times every day, namely, at three a. m. and three p. m., the height of the mercury in the barometer is to be read off and registered in inches and hundredths of an inch; the height of the attached thermometer is to be noted in degrees; and that of the thermometer in open air in degrees, and such fractions of a degree as can be estimated by the eye.

2. No partial heat, such as that of the sun's rays, a lamp or candle, the hand or the breath, should be allowed to affect either barometer or thermometer.

3. In reading off or observing the height of the barometer, care should be taken to move the index till the lower edges of both the front and back pieces of brass are seen in one line with the upper surface of the column of mercury: neither allowing light to be seen between, nor cutting off from the eye any portion of the mercury; in short, just touching as when the sun's image is brought down to the horizon by a quadrant.

4. To those who have not used a barometer, it should be observed that the divisions of the fixed scale are inches and tenths of an inch, and they are measured from the surface of the mercury in the cistern; that the moveable scale attached to the index is called the vernier, (or nonins;) that ten divisions on the vernier are equal to eleven on the fixed scale, greater than one such division. Supposing the vernier placed against the fixed scale, so that the upper line on the vernier should agree exactly with any division (say at thirty inches) of the fixed scale, and that the lower line of the vernier should agree exactly with another division (say twenty-eight inches and nine-tenths) of the fixed scale; if the vernier be gradually moved through a space equal to one division of the fixed scale, (or one-tenth of an inch,) it will be seen that each line in succession agrees with a different division of the fixed scale; and as there are ten equi-distant lines on the vernier, besides the first, it follows that the several agreements show equal parts of the tenth of an inch, through which space the vernier passes—that is, they show hundredths of an inch. For example, supposing that the top of the column of mercury stood higher than thirty inches and one-tenth, but not so high as thirty inches and two-tenths, and that when the index was moved so that it should be at the level of the top of the column, the fourth line of the vernier agreed with a division on the fixed scale, then the reading off would be thirty inches, one-tenth and four hundredths.

5. The height of the cistern of each barometer, above high-water mark at ordinary spring tides, should be noted in the register.

6. The corrections applicable to each instrument are marked on the part opposite the scale, and are registered at the Trinity house; but with those the light-keepers have no concern.

7. The directions and strength of wind, and the state of the weather are to be noted at three a. m., nine a. m., three p. m. and nine p. m. The direction of the wind is to be given by compass, and its strength denoted by a number less than fourteen; thirteen being supposed to represent a hurricane, and one the lightest breeze,

8. Each time of high-water and each time of low-water, the perpendicular rise of tide and the times of change in the directions of the stream, are to be registered as often and as accurately as may be practicable.

9. Time for these several observations may be obtained by watches showing mean time, or frequently set by the sun, when on the meridian, or when rising or setting. The latter will be apparent time, and in the register it should be noted whether mean or apparent time is used.

10. Every register should have the place, date, observers' names, and number of each instrument used inserted in its pages.

11. Whenever observations are omitted, blanks should be left in the register, and on no account filled up afterwards.

23 GREAT GEORGE STREET,
September 25, 1843.

SIR : The reference on the important subject of lightning conductors, is to Mr. Faraday and to me. On receiving it, I prepared drawings of the buildings to which our immediate attention was required, with an explanation of their present conductors.

These were considered at a meeting with Mr. Faraday, when he explained the principles and their application to the several cases, deduced from his copious experiments and scientific observations.

I have since received from him the accompanying report for my signature along with his, but the report is altogether Mr. Faraday's, and therefore I prefer adding my approval of all it contains in this separate sheet, and recommend that authority be given to me to act upon it.

I am, &c.,

JAMES WALKER.

Report on the lightning rods of light-houses.

September 25, 1843.

The undersigned have, according to their instructions, met and considered the circumstances under which light-houses are placed as respects lightning, and have arrived at the following conclusions :

That light-houses should be well defended from the top to the bottom ;

That as respects the top, the metal of the lantern and upwards is sufficient to meet every want, and satisfy every desire and fear ;

That for the rest of the courses down the tower, a copper rod three-fourths of an inch in diameter is quite and more than sufficient ;

That at the bottom where the rod enters the earth, it is desirable at its termination to connect it metallically with a sheet of copper three or four feet long, by two feet or more wide ; the latter to be buried in the earth so as to give extensive contact with it ;

That glass repellers are in every case useless ;

That glass thimbles are not needed, but do no harm ;

That if the repeller be removed, and the joint on the vane be terminated as the lightning-rods usually are, and then the metal of the lantern be strongly attached to and cemented with the upper end of the copper rod, and the rod continued down the tower to the earth, and the sheet of copper buried in it, such a system will be an effectual and perfectly safe lightning conductor;

That then there need be no rod end rising by the side of and above the lantern;

That the rod may (if required on other accounts) come down on the inside of the building or in a groove in the wall, but should not be unnecessarily removed from observation and inspection;

That all large metallic arrangements in the stone work in other non-metallic parts of the tower of the light-house, such as tying bars, metal flues, &c., should be well connected by copper with the conductor;

That the vicinity of two metallic masses, without contact or metallic communication, is to be avoided;

That as to the South Fireland high light, the lantern, the central stone, and the copper rod proceeding from it to the earth, connected as they now are, form a perfect lightning conductor, even without the rod that is there erected; but,

That it is important casual arrangements should never be depended upon for lightning conductors, but a copper rod be established for the especial purpose; for if the former be trusted to, the carelessness or ignorance of workmen may, at after periods upon occasions of repair or cleansing, cause the necessary metallic connection to be left imperfect or incomplete, and then the arrangement is not merely useless but dangerous.

That as to the Eddystone, it is desirable to connect the system of wrought-iron ties in it with the lightning conductor, by joining the lower part of that iron rod, which is nearest to the conductor, with the latter by a copper rod or strap, equivalent to the conductor in sectional area.

That the Dungeness light-house is in a very anomalous condition; to rectify which the two repellers should be removed, and also the representative of the top of a lightning rod attached to the flue; and that then a good copper conductor should be attached to the metal of the lantern, upon the principles already expressed.

M. FARADAY.

JACOB HERBERT, Esq., &c., &c.

Extract from minutes of the board, held on the 26th September, 1843.

Read a report from Professor Faraday on the reference made to himself and Mr. Walker, on the subject of the construction of lightning conductors for light-houses.

Read also, a letter from Mr. Walker conveying his approval of all that Mr. Faraday's report contains, and satisfactorily explaining the grounds on which he has not thought it right to sign the report. The board having hereupon considered and approved the suggestions offered in the said report, ordered that Mr. Walker be instructed to cause the light-houses belonging to the corporation to be protected by the means recommended by Mr. Faraday, and in which he expressed his entire concurrence as above said; and that Mr. Faraday be acquainted therewith.

Copy of Letters to Mr. Walker.

TRINITY HOUSE, LONDON,
September 29, 1843.

SIR: The report of Mr. Faraday on the subject of lightning conductors, having been laid before the board, together with the letter from yourself by which it was accompanied, I am directed to transmit the enclosed copy of the said report to you, and to signify the request of the board that you will cause the light-houses of this corporation to be protected by the means recommended by Mr. Faraday, and in which you have expressed your entire concurrence.

I am, &c.,

J. HERBERT.

JAMES WALKER, Esq., &c., &c.

TRINITY HOUSE, LONDON,
June 28, 1845.

SIR: Adverting to my letter of the 29th of September, 1843, I shall be obliged by your furnishing me with a list of the light-houses at which the improved lightning conductors have been fixed, and a general statement of the arrangements which you have made for carrying out the board's directions, by fixing them at those establishments at which they have not as yet been provided.

I am, &c.,

J. HERBERT.

JAMES WALKER, Esq., &c., &c.

23 GREAT GEORGE STREET, June 30, 1845.

SIR: I beg in reply to your letter of the 28th inst., to state that the improved lightning conductors have been fixed at the following light-houses, viz: Skerries, St. Ann's, Usk, Avon, Lizard, Eddystone, Start, Dungeness South Foreland, Haisbro, Spurn, Tynemouth, Flatholmes, and that Winterbore is now on hand. Of one thousand lineal feet of conducting rod that are now contracted for, only one hundred and seventy feet are delivered.

No opportunity that offered for carrying into effect the corporation's directions, to fix the improved conductor at all the light-houses, has been lost; but the work is of a nature that requires care, and a knowledge of a variety of trades on the part of the superintendent; therefore, where I have found that a particular individual has done the work satisfactorily, I have thought it better to take advantage of his tried qualities, than to set on a number of inexperienced hands to do so delicate a work.

I am &c.,

JAMES WALKER.

JACOB HERBERT, Esq., &c., &c.,
Trinity House, London,

H—No. 17.

IRISH LIGHTS.

Extract from Senate Document No. 488, 1st session, 29th Congress.

In light-houses, especially fixed lights, where any considerable portion of the circle is to be illuminated, say exceeding one half, (or more than 180°), refractors should be chosen, as light can with them be more economically used. There is, also, thus a more equal diffusion of the light around. In small harbor lights where an angle of only a few degrees is to be lighted, as in marking a channel, it will be, in most cases, found advantageous to use reflectors.

The general number of keepers to each light-house is two; a principal and an assistant keeper. There are only two light-house stations on the coast of Ireland in which there are three keepers to each; those are on the tidal rocks, having shore establishments.

The annexed document (in reply to No. 3) states the number of persons in each light-vessel, and the arrangement for relief.

Buoys are distinguished by differences of color, as black, red, &c., or any of these, with broad paralleled or diagonal belts of different colors, and by affixed beacons of different forms.

Light-vessels are moored by single anchors; (iron mushrooms from one and a half to two tons weight.) The chains are from one and three quarters to two inches in diameter, of iron, with studs or crossbars. Stone sinkers are generally used for buoy moorings, they weigh from twenty to thirty hundred weight each, according to the size of buoys. The chains are from one inch to one and a half inch in diameter, of iron, without studs. Mushroom anchors were formerly used for mooring buoys, but stone sinkers are found to be as effective (when the buoy alone is to be secured) and are not more than one-eighth the cost.

Weather being favorable, the length of time usually occupied in putting down one of Mitchell's screw moorings for a mooring-buoy, is from three to four hours. A strong raft, having a central opening, is best adapted for working the capstan, shears, &c.; but two floats or buoys, platformed over, lashed together, securely moored and well steadied with quarter-lines, form a ready and serviceable substitute.

The ballast board have several of these screws in use at Dublin and propose using them more extensively, both as moorings and as bases for beacons. Considered as moorings for one or many vessels, although taking the mere weight, they are necessarily more costly than ordinary moorings, yet, bringing into account their much greater power of holding, (in all places suitable to their use,) they would become, perhaps, the most economical that could be adopted.

Time will not now permit to attempt arranging the foregoing list of replies more methodically or more in detail. The report which it is expected will shortly be published by order of the select committee of the House of Commons, will contain any further details that might be wished.

GEORGE HALPIN, C. E.

DUBLIN, October 27, 1845.

H—No. 18.

Return to an order of the Honorable the House of Commons, dated 14th August, 1846.

A return by the corporation of Trinity House of Deptford Strond, showing whether they have adopted the recommendation of the select committee on light-houses, in the use of colza or rapeseed oil, instead of sperm oil, and what saving of expense has accrued therefrom; and also whether they have made any and what reduction in the light dues charged by them.

RAPESEED OIL.

The attention of the corporation of Trinity House had been drawn to rapeseed oil as a substitute for sperm oil, and trials of its qualities, with the object of introducing it into use at their light-houses and light-vessels, had been directed to be made prior to the sitting of the select committee on light-houses, in 1845.

Suitable arrangements for the burning of this oil have since been made and are continued as opportunities present themselves, and its use will probably become general at the light-house and light-vessel stations in England. The quantity which was contracted for and supplied in the spring of the year 1841, was thirty tuns, being so much, or nearly so, in diminution of the contract quantity of sperm oil, the respective contract prices being, for rapeseed oil, 3s. 9d. per imperial gallon; spermaceti oil, 6s. 4d. per imperial gallon. It must not, however, be supposed that the whole difference in the price per imperial gallon is actually saved, because the quantity of rapeseed oil consumed very considerably exceeds that of spermaceti oil, if the flame in the lamp be maintained, as it should be, at the maximum of its power.

The time which has elapsed since the use of this oil has been extended, has not been sufficient to show conclusively what the excess of consumption will be in practice; but the present results induce the expectation that it will be very considerable, and there do not, at this time, appear any certain grounds for supposing that the difference can be materially reduced.

In the autumn of 1845, the board referred the investigation of the power and qualities of the light produced from the combustion of this description of oil to Professor Faraday, and the following valuable and interesting observations, having reference to the question of consumption, are extracted from his consequent report, dated the 9th day of October of that year, viz: "Having burnt the lamp for many days, I have been much struck by the great steadiness of the rape oil lamps, either considered alone or as compared with the sperm oil lamps. They would burn for twelve or fourteen hours at a time, with little or no alteration of the light, the cottons or lamps not being touched the whole time; whereas the sperm oil lamps would, in the course of four, five or six hours, give a diminished flame, from the incrustation of the charred part of the cotton retarding the flow of oil. In the rape oil lamps the coal is broken and porous, and serves for wick almost as well as the fresh cotton; but in the sperm oil lamp, the coal forms a hard, continuous ring, which seals up the ends of the threads; and this, with the more confined condition of the burner, and the greater distance of the oil

beneath, (from intentional difference of flow in the lamp,) causes the sperm oil lamp flame to fall in brightness, and requires that the wick should be re-trimmed. Several causes conspire to this hard condition of the charred cotton, which I need not enter into here.

"I have made many careful experiments on the proportion of light produced by the two kinds of lamps, in every case weighing the oil before and after combustion, so as to know exactly the quantity burnt; and making, during the experiments, above a hundred comparisons of the lights, one with another. The rape oil lamps were always more brilliant than the sperm oil lamps, except, indeed, in one or two rare cases; but, at the same time, more oil was burnt in them. The observations were made numerous, that the errors in the perception of the eyes might compensate each other. In each particular experiment it was evident that the light was nearly in the proportion of the oil burnt; and upon making a comparison of all the results, the following conclusion was obtained: From one hundred and eight observations of the lights, taken at such times as appeared fitted to give the best mean expression of the light of the lamps, compared with the oil burnt in them, the average light of the rape oil lamp came out as one and a half, that of the sperm oil being one. This is the mean result of the light involved by the lamps burning for the same period of time. On summing up the amount of oil burnt in the same time, it gave almost exactly the same proportion; for the oil consumed in the sperm lamps being 1, that consumed in the rape oil lamps was 1.505. I have considerable confidence in this result, the quantity of oil consumed being several gallons, and the observations of the light very continuous and numerous."

*Supplementary return to an order of the honorable House of Commons,
dated August 14, 1846.*

"Statements by the corporation of the Trinity House of Deptford Strond, by the ballast board in Dublin, and by the commissioners of northern lights, showing whether they have adopted the recommendation of the select committee on light-houses, on the use of colza or rapeseed oil, instead of sperm oil, and what saving of expense has accrued therefrom; and also whether they have made any, and what reduction, in the light dues charged by them respectively."

Ordered by the House of Commons to be printed, 18th March, 1847.

Return by the commissioners of Northern light-houses.

1. Whether they have adopted the recommendation of the select committee on light-houses, in the use of colza or rapeseed oil, instead of sperm oil, and what saving of expense has accrued therefrom.

On the 10th January last, the engineer of the board reported on this subject to the commissioners, in the following terms: "At the suggestion of Mr. Hume, M. P., chairman of the light-house committee, I have obtained from Messrs. Wilkins, of Long Acre, a sample of an oil going under the name of oil of colza, but in no respect characterized by the pecu-

liarities which marked the colza oil of the French light-houses. This oil is burned in a lamp with a chimney indented at the flame by means of a deep, narrow groove on its outside, which seems to be the same as that which is used in what is called the solar lamp, and is now oddly enough termed the catoptric lamp. The oil is said to be nearly fifty per cent. cheaper than spermaceti, but is generally held to be more rapidly consumed. I have made several trials of the colza and the sperm oil in burners of different kinds, with somewhat contradictory results, both as regards brilliancy of effect and durability. I am not, therefore, prepared to offer any very precise information as to the result of my inquiry. It appears to me, however, that I may safely enough state that the colza oil is somewhat more rapidly consumed where an equally dense light is evolved, and its flame generally seems to contain a greater proportion of the orange color, which marks imperfect combustion.

“The adoption of this oil would involve an entire remodelling of the burners, so as to admit of thicker wicks, and would probably lead to an enlargement of the cellars, so as to receive a larger supply. I conclude, therefore, that during the present season the commissioners would not be warranted in doing more than to make trial of a cask or two of this oil at a dioptric and a catoptric light. I may add, that other reasons for proceeding somewhat cautiously in regard to the colza oil may be found in the uncertainty as to the source of supply, and the absence of all experimental knowledge of the effect of cold in causing it to become thick.”

The suggestions in this report having been approved by the board, a supply of the oil has been sent to several of the stations; but the result has not as yet been reported to the board.

A return by the commissioners of Northern light-houses, relative to the substitution of rapeseed oil for sperm oil, and the saving that has accrued therefrom.

To the first head of the preceding order, “Whether they have adopted the recommendation of the select committee on light-houses in the use of colza or rapeseed oil, instead of sperm oil, and what saving of expense has accrued therefrom,” the commissioners, in making a return to this order (presented to the House 26th August, 1846, Vetis No. 2) stated, that “a supply of the oil has been sent to several of the stations, but the result has not as yet been reported to the board.”

On 9th January last the engineer submitted a further interior report to the board, a copy of which is appended hereto (No. 1.)

The engineer having on the 10th instant reported to the board the result of the trials of the oil in question, the same is now submitted as a supplementary return to the order of the honorable House, and is appended hereto (No. 2.)

By order of the board,

ALEX. CUNNINGHAM, *Secretary.*

NORTHERN LIGHTS OFFICE,

Edinburg, March 13, 1847.

No. 1.

Excerpt from annual report by Mr. Alan Stevenson, engineer to the commissioners of Northern light-houses, dated 9th January, 1847.

The trials of the colza oil alluded to last year, as suggested by Mr. Hume, M. P., late chairman of the light-house committee in 1845, have just been commenced, and, in so far as the reports from the stations have been received of the preliminary experiments, there is reason to believe that this oil will answer in light-houses. The question of the relative expense of the colza and spermaceti oils, however, must remain undecided until farther trials shall have been made; and longer experience is also desirable, in order to show in what manner the oil is acted upon by frost. The stations fixed upon for the trials are Inchkeith, Isle of May, Kinnaird's Head, Cornwall, Little Ross, and Calf of Man, three being dioptric and three reflecting lights.

No. 2.

The report of Alan Stevenson, engineer.

EDINBURGH, March 10, 1847.

In my last annual report on the state of the light-houses, I directed the attention of the board to the propriety of making trial at several stations, of the patent colza or rapeseed oil prepared by Messrs. Briggs, of Bishopsgate street. These trials have now been made during the months of January and February, at three catoptric and three dioptric lights, and the results have from time to time been made known to me by the light-keepers, according to instructions issued to them, as occasion seemed to require. The substantial agreement of all the reports as to the qualities of the oil, renders it needless to enter into any details as to the slightly varying circumstances of each case, and I have therefore great satisfaction in briefly stating as follows the very favorable conclusions at which I have arrived:

1. The colza oil possesses the advantage of remaining fluid at temperatures which thicken the spermaceti oil, so that it requires the application of the frost-lamp.

2. It appears from pretty careful photometrical measurements of various kinds, that the light derived from the colza oil is, in point of density, a little superior to that derived from the spermaceti oil, being in the ratio of 1.056 to 1.

3. The colza oil burns both in the Fresnel lamp and the single Argand burner with a thick wick, during seventeen hours, without requiring any coaling of the wick or any adjustment of the damper; and the flame seems to be more steady and free from flickering than that from spermaceti oil.

4. There seems (most probably owing to the greater steadiness of the flame,) to be less breakage of glass chimneys with the colza than with the spermaceti oil.

5. The consumption of oil, in so far as that can be ascertained, during so short a period of trial, seems in the Fresnel lamp to be 121 for colza, and 114

for spermaceti; while in the common Argand, the consumption appears to be 910 for colza, and 902 for spermaceti.

6. If we assume the mean of these numbers, 515 for colza, and 508 for spermaceti, as representing the relative expediture of these oils, and if the price of colza be 3s. 9d., while that of spermaceti is 6s. 9d. per imperial gallon, we shall have a saving in the ratio of 1 to 1.775, which, at the present rate of supply for the northern lights, would give a saving of about £3,266 per annum.

Of these conclusions, the three last may be considered as more or less conjectured, being founded on data derived from too short a trial; but the striking agreement of the results obtained at the six lights in which the experiments were made, tend in some measure to supply the place of a longer period of trial; and I have no hesitation, therefore, in recommending the board at once to introduce the use of the colza oil into all the dioptric lights, except that of the Skerryvore, where some special reasons induce me to defer the change for another season. In the catoptric lights, the only reason for not making an equally extensive trial is the necessity for renewing all the burners, which require to be so constructed as to receive thick wicks of brown cotton; and it may perhaps be considered prudent to proceed with some caution in changing the apparatus so as to suit for burning a patent oil, the circumstances attending the regular and extensive supply of which are not yet fully known. I may remark, that I have burnt the colza oil in the solar lamp alluded to in my last report; but I disapprove of it as tending to elongate the flame vertically, and thus to decrease its horizontal volume. The elongated form of flame increases the divergence vertically when the light is lost, and so far circumscribes its horizontal range where it is most required. I have therefore respectfully substituted the thick wick-burner for the solar lamp, whereby an equally complete combustion is obtained, and the proper form of the flame is at the same time preserved.

To the BELL ROCK COMMITTEE.

H.—No. 19.

Letter from W. C. Wilkins, Esq.

LONDON, *July 18, 1850.*

SIR: In answer to your letter of 29th of May, requesting information concerning improvements in light-houses and light-vessels, I beg herewith to enclose a book which I have recently published containing drawings and particulars of the various catadioptric light apparatus on Fresnel's system, used in this country, including two apparatus, for which I have obtained letters-patent in connection with M. Letourneau, of Paris; one is a revolving light, short eclipses produced by a new arrangement of the lenses, of the central part and additional vertical prisms, gathering the rays from the upper and lower catadioptric portions giving a great increase of light, and is what I am now exhibiting in the great crystal palace, Hyde Park; the other is a reciprocating apparatus with additional vertical prisms before mentioned, and reduce the cost of flashing light when it is not required to be seen beyond the same circle, or half the horizon.

I have also effected great improvements in revolving floating lights, by placing the machinery below the deck, thereby avoiding the liability to injury and producing a better action. I have enclosed circulars of these novelties, to assist in conveying the idea of their advantage to you.

In reply to the latter sentence of your letter, seeking intelligence respecting the oils, I beg to say that the colza or rapeseed oil is in constant use here; it has quite superseded sperm, and with suitably constructed lamps, wicks, &c., gives a better light and is more economical. (I shall be happy to supply you with a sample.) After it has been pressed from the seed it is purified by a patent process, which is of course secret—known only to the parties who manufacture it: the price averages about 3s. 10d. per gallon, but fluctuates according to the demand. Numerous experiments have been tried under the direction of Professor Faraday, and he considered the rapeseed oil as superior to all others for the purpose of illuminating light-houses, &c.

Trusting that this will meet your approval and contains what you wish to know, and that I may be honored with your future commands, which shall always have my best attention,

I am, sir, your most obedient servant,

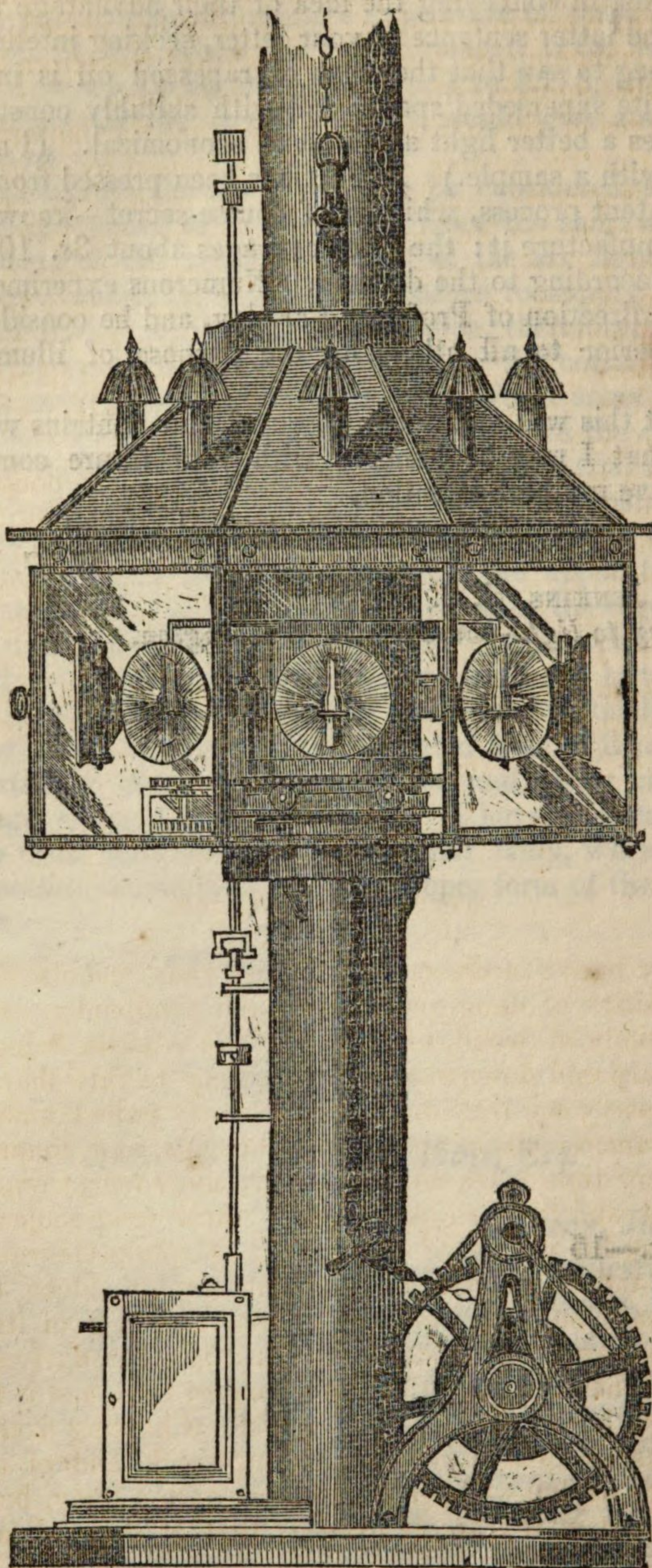
W. C. WILKINS.

Lieut. T. A. JENKINS, U. S. N.,

Secretary to light-house board, Washington.

Ex.—15

IMPROVED LANTERN AND REVOLVING APPARATUS FOR A LIGHT-VESSEL.



By W. C. WILKINS, light-house engineer, 24 and 25 Long Acre, London; manufacturer to the honorable corporation of Trinity House.

The principal improvements consist in constructing the machinery to work beneath the deck, instead of in the lantern as formerly. A vertical rod, working in metal bearings, is attached to the mast, with a large gun-metal pinion fixed to the top of the rod, at the height to which it is necessary to hoist the lantern, wherein a train of cog-wheels are placed, to connect with the pinion and communicate the motion obtained therefrom to the transversing apparatus that supports the lamps and reflectors.

The advantages of this arrangement are, that the lanterns can be made much lighter; that the rolling of the vessel caused by so great a weight at the mast-head, is greatly diminished; and the machinery, being more under control and better protected, works with greater regularity and precision. In the opinion of experienced persons, these improvements are most important, and the uninitiated may form an idea of their utility by reflecting that the situations in which light-vessels are placed are at all times difficult of access, and in stormy weather, when accidents are most likely to occur, quite unapproachable; so that it will be obvious any alteration which reduces the liability to derangement is greatly to be appreciated.

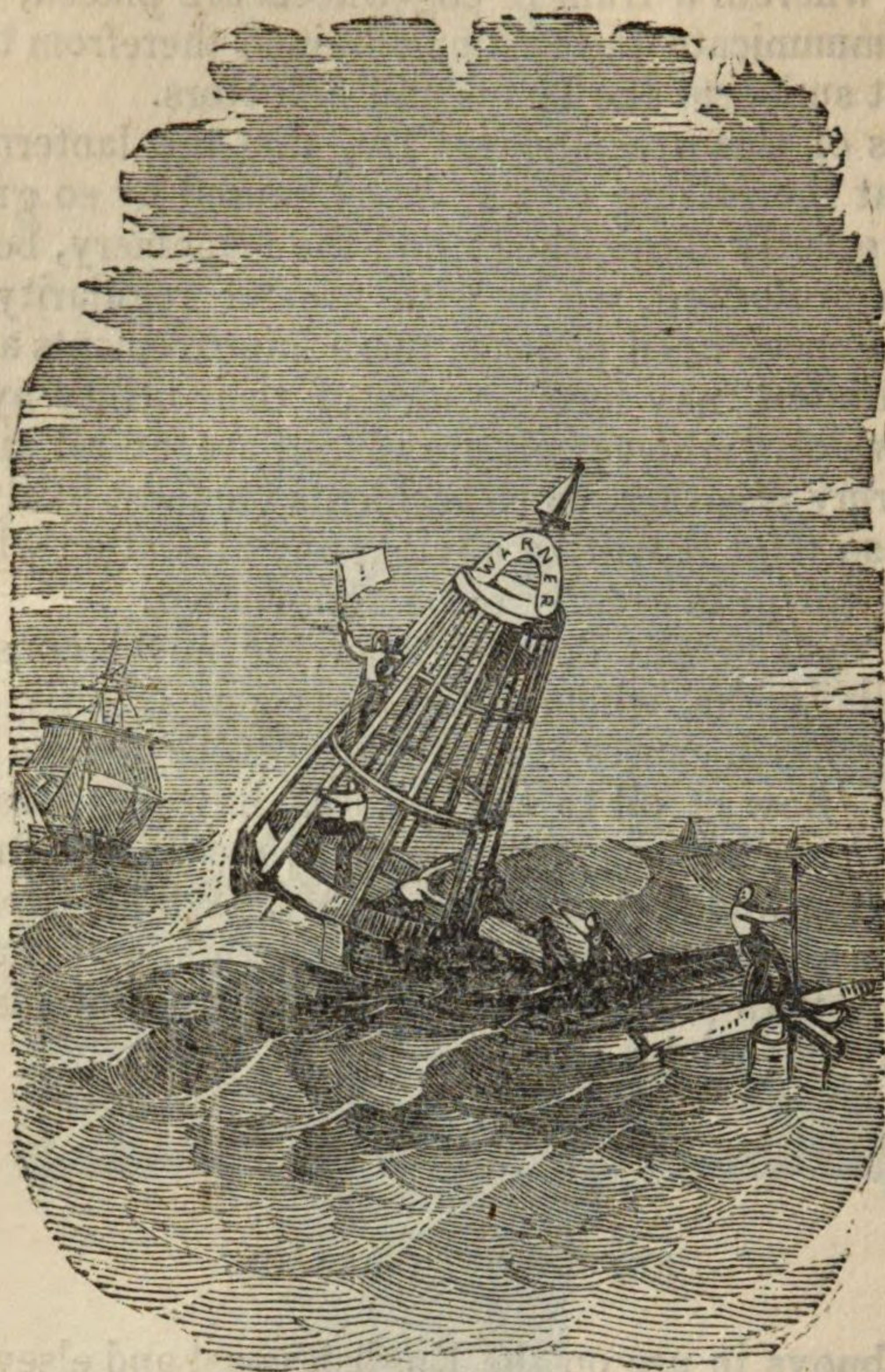
There is also a vast benefit derived from the novel construction of the lamps and gimball works, which, by a movement exactly coinciding with the motion of the vessel, causes a perfect level to be always maintained, and insures the proper flow of oil to the burners, however irregular that motion may be. That improvement is not of so recent an introduction as the former; but when it was first invented by Mr. Wilkins it produced a complete revolution in the apparatus for floating-lights, and enabled the beautiful Argand lamp, with parabolic reflectors, to be used instead of the old lamps with smoky flat wicks.

REFUGE BUOY-BEACON.

The ordinary buoys in use on the English coast and elsewhere, for pointing out the position of dangerous shoals and sandbanks, are of a conical form, made chiefly of wood, and hooped like a cask, being moored with the apex or sharp end downwards; and, owing to this shape, in a strong tide-way and heavy sea they are at times nearly pulled under water, tugging with an immense strain upon their moorings, and frequently breaking adrift at the very time when most required; moreover, from their construction, they twist and twirl so as to render them impossible of approach or refuge for saving life in case of shipwreck. Captain George Peacock, the superintendent and dockmaster of the Southampton docks, has invented a new kind of mark-buoy, or floating-beacon, which, from its peculiar form and construction, and the manner in which it is moored, rises over the crest of the waves in the heaviest gales and strongest tide, and is not acted upon like the ordinary buoy; it is, in fact, capable of holding from ten to twelve persons with ease in case of contiguous shipwreck, and of affording them a safe temporary asylum—it being in fact at once a buoy, beacon, and life-boat; and the cost of it scarcely exceeds that of the ordinary buoys now in use.

The plan and model having been approved of by the pier and harbor commissioners of Southampton, one of these buoy-beacons was laid down off the Spit, at Calshot Castle, on the 12th of August last, and has with-

stood the whole of the severe gales of the last six months without showing the least symptom of injury or leakage.



Captain Peacock's refuge buoy-beacon.

The hull, which is of sheet iron, is of a semi-oval shape, like the horizontal half of an egg, being ten feet long, seven feet broad, and three feet deep: the deck, a perfect oval, is convex, with a man-hole and cover in the centre. A kelson of pine timber, eighteen inches deep and fourteen inches broad, is fitted to the inside, running fore and aft, and fayed on to the shape of the bottom upon the rivets; and the mooring-bolt, with a broad bearing-shoulder, is passed diagonally up through this kelson and firmly secured by a large nut over a plate of iron or washer on the top of the same. This mooring-bolt is also fixed at one-third the length of the hull from the large end or breast, and along the other two-thirds of the bottom an iron keel, fifteen inches deep and 250 pounds weight, is riveted on with angle iron, and bolted through the kelson, which keeps the buoy steady to the tide, and also gives it stability. To the side or rim, which is eighteen inches deep and inclined inwards, uniting the deck with the bottom, eight triangular-shaped wooden uprights are fixed at equal distances in outside sockets bolted through with nuts and screws: these stancheons are nine feet in length, terminating and dovetailing into an oval platform, five feet by four feet, and are braced horizontally by two rows of corresponding pieces at equal dis-

tances from each other, the first row being four feet from the deck; and the divisions above this are nearly filled up by the vertical battens to the top of the platform, all firmly united with hoop iron. There are also two diagonal braces of rod-iron, which cross each other in the centre of the structure; whilst seats are fixed at each end on a level with the first horizontal brace pieces, affording accommodation for six persons, and leaving standing room for six more in the centre of the deck. Under the platform a large bell is fixed with four swinging clappers hanging round it from the platform and striking the outside; whilst the centre clapper has its stem below the hammer elongated with rod iron to five feet, terminating in a wind-cross of thin sheet iron, so as to ring the bell with the least breeze when the water is too smooth to affect the clappers.

Above the platform, arching from side to side, is a semicircle of square iron rod, which assists in uniting the sides or top ends of the uprights or stanchions to the platform, and to which rim is riveted a plate of thin iron, with the name of the buoy painted on it; and above the centre of this arch, forming the apex of the buoy-beacon, is a spindle carrying a pyramidal speculum, ten inches in angle, which, revolving freely as the buoy moves, reflects the rays of the sun and moon, and occasionally Calshot light: the reflected flashes of the sun's rays are visible at a distance of seven to eight miles from a vessel's deck, and the buoy-beacon itself is seen in clear weather four to five miles off, or three times the distance of ordinary buoys of the largest size; in thick weather it looms like a small vessel at anchor. The top of the speculum is twelve feet above the water-line.

The commanders of steamers and other vessels frequenting the port of Southampton, and all the pilots, give a unanimously favorable report of this buoy-beacon, and strongly recommend its general adoption upon all outstanding dangers: they say that it rises over the tops of the seas without plunging or diving, or being in the least affected by the action of the tide beyond sheering from side to side within the scope of its mooring chain during a gale across the tide, and thus rendering itself more conspicuous by presenting two-thirds of its broadside each way alternately; and in heavy gales of wind from the most exposed quarters, namely, SE. and WSW., at the strongest period of a spring tide, it is seen to ride upon the crest of waves that completely overwhelm the neighboring buoys of the Bramble, Leep, &c. It has not been baled or pumped out since it first went into the water; and upon taking off the manhole-cover, after it had been laid down six months, it was found to be as tight as a cup. As a proof of its stability, two persons at one time have sat on the top of the platform when afloat, without its showing any signs of being crank. The cost of this buoy-beacon, including bells, fittings, &c., was £55.

H.—No. 20.

Letter from Jacob Herbert, esq., Secretary to the Trinity House Corporation.

TRINITY HOUSE, LONDON,
September 3, 1851.

SIR: I beg to acknowledge the receipt of your letter, dated 27th May last, stating that you are directed by the light-house board in session in

conformity to a recent act of Congress (copy of which its therewith transmitted) to address this corporation, for the purpose of obtaining information which it is considered they may be enabled to furnish, either of a general or specific character, with a view to the improvement of the present condition of the lights and other aids to navigation belonging to the government of the United States; and thereupon calling the attention of the Elder Brethren to certain particular inquiries deemed of major importance, embracing a period of time subsequent to the date of the House of Commons' report of 1845.

And having laid the same, with its accompanying printed documents, before the board, I am instructed to communicate to you, as secretary to the light-house board of America, the following replies which the Elder Brethren have directed to be given to the queries referred to, in the order in which they occur in your said letter, and which I trust will convey the desired information.

I have the honor to be, sir, your most obedient servant,

J. HERBERT.

To Lieut. THORNTON A. JENKINS,
U. S. N., Washington City, U. S.

H—No. 21.

Q. As to the changes which may have been made in the mode of constructing light-house towers; the different descriptions of materials used, which is considered the best under all circumstances, referring specially to durability, economy and efficiency as permanent structures, having regard to annual expense for repairs?

A. The mode of construction remains unchanged, except that, as respects material, iron-plate houses have been erected in some of the British colonies. As a general rule, stone is preferable, but much depends on locality and other circumstances.

Q. What has been the experience of the board in the use of the screw-pile and Potts's cylinders for special locations where hydraulic structures would have been attended with great expense or difficulties which could not have been easily overcome? What objection, if any, to cast-iron hollow towers in general? What has been the effect of vibration and torsion of the pile structure and of vibration upon the hollow cast-iron towers, so far as the Trinity board has been informed?

A. Neither the screw-pile nor Dr. Potts's cylinder have been extensively used by the Trinity House. The vibration of the pile structures is sensibly felt. No torsion has been observed. The board has had no experience of cast-iron hollow towers.

Q. The results of trials of mortars and cements for stone and brick towers; the effect of the sea atmosphere on hydraulic and other light-house structures?

A. These are points for the opinions of engineers.

Q. Improvements, if any, in illuminating apparatus since 1845?

A. The dioptric lights have been improved by the substitution of zones of prisms for concave mirrors.

Q. What number of new lens or Fresnel lights? What number of old

reflector lights renewed by the introduction of the lens apparatus, and what the whole number of lights introduced since 1845? Have lenses of the smaller classes been introduced for harbor and river purposes?

A. Three new lens lights have been established, viz: one at Trevoze Head, and two in Sea Reach. The Milford high, Eddystone and Spurn low lights have been renewed in the manner mentioned; a catadioptric apparatus of the first, second and fourth orders, respectively, having been substituted for the Argand lamps and parabolic reflectors theretofore in use thereat. Lenses of the fourth order have been introduced and still are in use for harbor and river lights.

Q. What the comparative useful effect and economy of that class or order of lights, with the reflector lights in similar positions? What the relative economy and useful effect of the two systems as demonstrated by experiment at the South Foreland lights and other places in a series of years, all things else being equal?

A. The comparative economy depends upon the number of lamps required under the old or reflective system.

Q. What lamp is in most general use in the lens lights, the Carcel, pneumatic or hydraulic lamp? The advantages arising from the use of the one or other?

A. The hydraulic or fountain lamp is universally in use in the light-houses of the corporation, with one exception (the South Foreland high) where the light is shown from a Carcel lamp; the disadvantage arising from the use of which is the occasional derangement of the machinery.

Q. What the most approved lamp for reflector lights?

A. An Argand lamp: the burner seven-eighths of an inch in diameter.

Q. What improvements in ventilation? Have Prof. Faraday's tubes been generally introduced?

A. Prof. Faraday's tubes have been fitted at all the light-houses.

Q. How often do the best quality parabolic reflectors in use in the Trinity House lights require renewing?

A. Not for many years with care, say from twenty-five to thirty.

Q. How long do the best slide lamps and burners last with ordinary repair?

A. The best Argand burners, when new, last from two to three years; the lamps a much longer period.

Q. What is the difference in first cost and what the difference in annual expense of the two systems, comparing lights of the same class or order of the two systems in which other circumstances are equal? What the difference in useful effect, &c., &c.?

A. The difference in first cost is in favor of the reflector lights, as follows, viz:

For the dioptric apparatus complete, about-----	£1,030
Lantern, pedestal, &c., &c.-----	1,940
	----- 2,970
Reflecting apparatus complete, about-----	388
Lantern, pedestal, &c., &c.-----	1,940
	----- 2,328
Difference-----	£642

Q. Have any difficulties attended the management of the Carcel, or other

single burner lamps, since the introduction of the lens lights into Great Britain?

A. No difficulties have attended their management; the only disadvantage is pointed out under the above reply to the third query.

Q. What difference is made in regard to numbers, salaries and qualifications of keepers in the two systems?

A. No difference is made in these respects.

Q. Have any improvements been made in the illuminating apparatus of light-ships? Are Argand burners and parabolic reflectors mounted on gimbals used on board the Trinity House light-ships?

A. Argand burners and parabolic reflectors mounted on gimbals are used on board the Trinity House light-vessels.

Q. What kind of fog-signals are employed?

A. A gong is sounded.

Q. Have any new modes of distinguishing lights been introduced? and what are now employed?

A. No new modes have been introduced. Distinctive character is obtained by varieties of fixed, revolving, intermittent and colored lights.

Q. What number of persons constitute the crews and officers of light-vessels in exposed positions, and what number in rivers, bays, &c., &c.; what the tonnage of the light-vessels on the Goodwin sands and in other exposed situations?

A. Eleven persons in all, consisting of a master, mate and nine seamen, excepting in one instance, in which the number of men is fifteen, (seventeen hands in all.) One hundred and sixty tons more or less by builder's measurement.

Q. What descriptions of oils are used in the lights of England?

A. Colza or rapeseed, refined.

Q. How are they tested before being received?

A. Tested by experimental burnings.

Q. What number of light-vessels kept for relief?

A. One in each district; the number of floating light stations in the several districts varying from eleven to three.

Q. What has been the result of trials with colza or rapeseed oil, chemical and gas lights, etherial oils, &c., &c.? Do you use different qualities of oils for winter and summer?

A. The result, at present, is the invariable use of refined oil from rapeseed, as before stated. No other oil is used.

Q. Of what materials are lanterns, in general, constructed for the Trinity House lights?

A. Lanterns are constructed of copper or gun metal.

Q. What advantages arise from the use of bronze?

A. Bronze, like gun metal, does not corrode.

Q. What description and sizes of glass for sea-coast lights?

A. Plate glass: the dimensions of the panes vary. In the first order lights from 48 by 41 inches, to 35 by 29; second order lights from 41 by 39 inches to 22 by 19. The thickness of the glass being ordinarily three-eighths of an inch; in exposed situations five-eighths of an inch.

Q. How is the glass put in, by being glazed with putty, or by other means?

A. The panes are fixed by means of a composition of white and red lead termed plate-glass cement.

Q. What precautions are observed to repair such casualties as the breaking of glass by wild-fowl, mechanical lamps, or movable machinery getting out of order, &c.?

A. No precaution is taken against the breaking of the glass by wild-fowl, but spare panes are kept in store; instances of breakage are very rare. Movable machinery, &c., seldom gets out of order, and no particular precaution is therefore considered necessary.

Q. What precautions are taken to prevent unnecessary waste of light by absorption in the lanterns?

A. The inner part of lanterns is painted white.

Q. Are sea-coast or other first class lights permitted to be left after lighting up at sun-setting and before being extinguished at sun-rising, without a keeper in the lantern?

A. No. A keeper is always in the watch-room. (Vide printed instructions to light-keepers.)

Q. What is the general system of inspection. How often and by what class of persons?

A. By superintendents of districts, and frequently by members of the board.

Q. How are supplies delivered—by tenders or by contract vessels? How often per annum, and under whose direction, &c.?

A. By the corporation's vessels once a year; or oftener, if necessary, under the board's order.

Q. What the comparative expense of the Maplin sand screw-pile light, with a first class light ship, per annum, and which is the most efficient?

A. The Maplin screw-pile light in the year 1849 cost, say £455. The light-vessel at the north end of the Goodwin sand, say £1,048.

Q. Any information on the subject of buoys, beacons and sea-marks, with reference to inspection, distinction, &c., is desired.

A. They are constantly inspected and are distinguished by difference of color and character.

Q. Modes of giving publicity to proposed changes in regard to lights, &c. How long before the change is made, and what specific means employed to give extended circulation at home and abroad?

A. By advertisement in the principal daily newspapers of the metropolis, &c., in a few of the periodicals generally perused by mariners. Separate notices are also fixed up and distributed at the different custom-houses, and copies sent to the consuls-general of the various foreign governments likely to be interested in the notifications. In some cases preliminary notices are issued.

Q. Any printed forms, circulars, reports, descriptive lists, general and special instructions, &c., upon the subject of lights, buoys and beacons, under the Trinity House corporation, will be most acceptable.

A. General instructions to light-keepers; general instructions to masters and mates of light-vessels; directions for management of refracting and reflecting lights to light-keepers; directions for management of reflecting lights on board light vessels; various forms of account of oil, &c.; inventory of stores for a light vessel.

APPENDIX K—No 1.

EAST INDIES.

Colaba.—Colaba light-house, Colaba floating light-vessel (outer), Shannon inner light-vessel, the property of the East India company. The light-house is one hundred and thirty feet, and the light-ship's lantern sixty feet above the level of the sea. The light-house may be seen, in very clear weather, about seventeen to eighteen miles, the outer light-vessel about twelve or thirteen miles.

The light-house tower is round; the sea does not affect it, and it stands the weather well; built of stone, and resists the wet well; whitewashed outside. It is ventilated by windows at the summit, and small square holes in the masonry on the sides. The building is free from damp, and stoves are not required.

Light-house revolving and floating lights fixed; common lights with reflectors. Light-house has three faces, each exhibiting its greatest light every two minutes. Machine wound up once during the night.

The light-vessels have each eight Argand burners and plated reflectors; lights at sunset and extinguishes at sunrise; the panes are $19\frac{1}{2}$ inches wide, two feet long, and half an inch thick, eight in number, on board of the light ships; outer light-vessel seven fathoms at low water; the ground chains are 70 fathoms each in length, with a bridle of 70 fathoms $1\frac{1}{2}$ -inch best European chains, with two bower anchors of 15 cwt., and two chain cables of $1\frac{1}{8}$ -inch. The mooring anchors are of the mushroom description, and 25 cwt. each; mooring sighted every Saturday, in the fine season, and whenever the weather permits during the SW. monsoon.

At the light-house there are resident keepers attached to the light. A regular watch is kept, and they are required to call out "all's well," at stated periods during the night.

The retired lieutenant of the Indian navy, in charge of the light-house, keeps a journal of proceedings and expenditures of stores. They keep a log on board of the outer light-vessel. The expenditure of stores is kept at the master attendant's office; the log is sent on shore to the master attendant's office every Monday.

Any wreck, or vessel in danger or distress, is immediately signalized from the light-house, and a gun fired to call attention to the signal. Oil is kept in iron tanks.

Three months stores are supplied every quarter to the light-house and light-vessels, and are kept dry in proper lockers; four spare burners are kept on board of each vessel, but the reflectors are kept on shore, as liable to injury on board; they can, however, always be obtained at short notice, when required.

The light-house is visited by a committee of officers appointed by the commander-in-chief of the Indian navy, as required, and the stores are also surveyed; the annual repairs are superintended by officers of the engineer department. The lieutenant in charge frequently visits the lantern and the pilots in charge of the light-vessels attend to the trimming of the lights; the reflectors are surveyed by a committee with which an engineer is associated, and if defective, the necessary repairs are effected. The East India light-vessels are fitted with Argand burners and reflectors, as in England.

COAST OF AFRICA—GREEN POINT.

A leading light; height of focus of light fifty-two feet; height above high-water level sixty-five feet; visible at the distance of $14\frac{3}{10}$ nautical miles from eighteen feet above high-water level. It is first of the fourth class, dioptric light; lamp and apparatus made by H. Lepaute, Paris.

One resident keeper, no other occupation; the keeper has had no training, except that of being instructed by the engineer department, in the manner of keeping the light; salary £60 a year; no assistant.

A return of the quantity of oil consumed each night, is regularly kept; oil used is extracted from the tips of the tails of the cape sheep; consume about two hundred and ten gallons per annum; under the orders of the colonial engineer.

MOUILLE POINT—(NEAR CAPE TOWN.)

Harbor light; fourth order of lenticular apparatus; fixed; height from light to high-water mark forty feet; visible at the distance of $12\frac{1}{3}$ nautical miles from eight feet above high-water level; erected in 1844; lamp and apparatus made by H. Lepaute, Paris.

One resident keeper; salary £60 a year; no assistant. Consumes about one hundred gallons of oil; two spare lamps and four spare burners.

Extract from returns showing the annual expense of maintaining British colonial lights.

Nova Scotia lights average about-----	\$1,150 00
Three lights built and maintained by the British government, in the gulf of St. Lawrence, each-----	2,145 00
New Brunswick lights average-----	1,281 00
Morant Point, Jamaica, about-----	2,000 00
Honduras, one light, about-----	1,800 00

BAHAMAS.

Abaco, Gun Bay and Cay Sal bank average each about-----	1,500 00
Port of Georgetown, British Guiana, average annual expense from 1829 to 1845 inclusive, about-----	1,800 00
St. Lucia, harbor light-----	250 00
Tobago on Bacolet Point, about-----	575 00
Trinidad, annual expense from May 1842, to September 1846, about-----	1,650 00
Gibraltar, Europa Point, average for five years from 1841 to 1846, inclusive (lens light)-----	1,350 00
Malta, average about-----	650 00
Cape Coast “-----	500 00
Fort of Colorado, from 1829 to 1845, average-----	200 00
Do. annual average of repairs-----	280 00

Europa Point light is a first order catadioptric fixed light; has two keepers, who keep a regular watch in the lantern—the night being divided b

tween them. Erected in 1841. Lantern altered to extend the light in 1843. Spray flies over the lantern with strong southeast winds. Centre panes of glass 41 inches by 25—about $\frac{1}{4}$ -inch thick. Spare pane can easily be put in to supply a broken one. Supplies received from Trinity board, London. Has one spare lens, which could be easily put up in lieu of a broken one. Keepers are paid £85 and £65, with a small allowance for fuel and water, and one suit of clothes each, annually. They are supplied with a Bible, prayer-book and sermons. Tower is built of rock limestone; resists the wet perfectly. Some dampness observed from defective window-frames. Reports are made monthly and quarterly to the superintendent, who transmits them to the secretary of the Trinity board. Wrecks are noticed in the journal. Sperm oil was used from the beginning until a year ago, (1848;) now, rapeseed oil. Average quantity consumed per hour, one pint; yearly average, 484 $\frac{1}{2}$ gallons. Oil does not congeal in this climate. The principal keeper thinks there is but little difference between the two oils. The panes of glass are smoked to a trifling degree after the light has been burning all night. Ventilated by means of an air chamber immediately under the light-room.

The following are the articles furnished by the Trinity light-house board annually:

Greatest quantity.	Least quantity.
300 yards concentric cotton wicks-----	170
80 dozen Argand cotton wicks-----	40
9 dozen ball cotton-----	7
17 dozen large cylinders-----	14
59 ounces polishing powder, for lenses-----	57
22 yards cleaning cloth for lenses-----	16
31 yards cleaning cloth for plate-glass-----	20
34 skins-----	20
59 pounds tow-----	40
17 pounds powder for brass-work-----	10
11 pounds powder for copper-work-----	3
1 gallon spirits of wine-----	$\frac{1}{2}$
4 sponges-----	2
8 woollen rubbers for brass-work-----	2
8 woollen rubbers for copper-work-----	2
4 flexible brushes-----	2
4 curved brushes for lenses-----	2

Are kept dry in tin boxes supplied for the purpose. Four spare lamps; one spare lens, complete, and thirty mirrors. Accounts kept by the light-house keeper, examined by the superintendent and audited by the Trinity board. The keepers act under printed instructions from the Trinity board. Superintendent's visits are weekly; more frequently when any repairs are going on. His salary is £40 per year, and five per cent. on the dues collected at Gibraltar. Have a barometer, an external and internal thermometer, a weather-cock, and a clock, which is corrected every night by the rock gun.

SIMONS BAY.

Roman rocks; floating light, revolving. It is a bright revolving light, thirty-seven feet above the level of the sea, and may be seen in clear

weather at the distance of ten miles from the ship's deck. Wound up every hour and a half. Revolutions, when vessel is rolling, with occasional jerks; otherwise regular. Chain broken once since it commenced operations. Spare chains, reflectors, and Argand lamps. Four light-keepers on board. Moored in fifty-eight feet water, with three anchors, weighing forty-two, forty-nine, and forty-five hundred each, with seventy-four, sixty-two, and sixty-two fathoms; size of chains, $1\frac{5}{8}$ inch each.

Light-keepers live on board. A regular watch is kept. Burns about sixty gallons per Argand lamp per annum. Ventilated by air-valves in bottom of lantern.

Light vessel is occasionally visited by the master commanding her Majesty's ship Seringapatam, and reported to the senior naval officer.

CAPE L'AGULHAS.

Coast light; first class, brilliant white light; refracted light. Lamps and apparatus made by H. Lepaute, of Paris. As yet has suffered no injury, except one pane of glass cracked slightly in a heavy gale of wind. Two light-keepers reside on the spot; keep alternate watches. The keepers have had no training, except that of being instructed by the Engineer Department in the manner of keeping the light. A return of the quantity of oil consumed each night is regularly kept. The keeper makes a report, twice a week to the government, of vessels seen to pass, or of any circumstances deserving remark. Salary of keeper £80, and assistant £50 a year.

Oil used is extracted from the tips of the tails of Cape sheep. This oil is found to be far superior to any other oil for brilliancy of light; costs 10s. 6d. per gallon; is prepared by the Engineer Department; not liable to congeal. Consumes about seven hundred and thirty gallons per year. Rapeseed and other oils, both animal and vegetable, have been tried and found inferior to the sheep's-tail-tip oil.

Two spare lamps, five spare burners, twenty-two spare mirrors. Keepers watch by turns.

A light-house is recommended for Cape Point. "The only building required for the light is a platform, the point itself being eight hundred feet above the level of the sea, and the expense beyond the lenticular light would consequently be trifling."

WEST INDIES.

Tobago is a fourth order dioptric light; fixed white light. Keeper would be dismissed if found off his watch at night.

Morant Point, Jamaica.

Cast-iron tower, one hundred and fifteen feet above the level of the sea; can be seen twenty-one miles in clear weather. Iron painted white; the wet has no effect upon it; erected and completed in 1842. Nothing has since been done to it, with the exception of painting twice a year. Revolving reflector light; reflectors made of platina; reflectors about two inches apart. Rapeseed oil received, and will be used so soon as the sperm oil now on hand is consumed.

When repairs are necessary to the buildings or apparatus, the light-houses are visited by the officer of engineers stationed at the Bahamas, who at his visit reports generally to the governor of Bahama, who forwards the report to the Secretary of State for the colonies. These inspections take place generally twice a year.

NORTH AMERICA.

Cape Bonavista, Newfoundland.

Revolving reflector light; frame four sides; alternately red and white light; reflectors parabolic, curve silvered on copper. One keeper and one assistant watch regular; never left with one person. Best pale seal oil used. Each lamp consumes about forty gallons a year. Consumption per night depends on the wind; in high winds more oil is consumed than in calm and moderate weather.

An officer is appointed to superintend the necessary repairs of the several light houses.

St. Paul's island, gulf of St. Lawrence.

Two leading lights; third order, large size, dioptric lights, one fixed and the other revolving; eight lenses each. Lights visible at all times ten miles; lights sixty to one hundred feet; keeps a table of wind and weather.

The lights in British North America are generally fitted with Argand burners, and large parabolic reflectors, twenty-two to twenty-four inches in diameter. Glass of lantern three feet by two and a half feet. Four resident keepers; regular watch kept. Principal keeper £300; assistants £120 each, per annum. Regular journal kept and transmitted weekly to the commissioners; journal of wind and weather kept, and forwarded weekly. Sperm oil; two gallons per night consumed; kept in under-ground cellars, in iron casks and tin cans.

Gun Cay Light.

Revolving reflector light. One keeper and one assistant; keeper and assistant divide the night into two watches—from sunset to midnight and from midnight to sunrise. Keepers have been long in the employ. Principal keeper £70, and the assistant £30 per annum. Journals are kept and monthly reports are made.

The light-house is visited frequently by the officer of Royal Engineers, stationed at Nassau, for the purpose of ascertaining the condition of the buildings and machinery. Rapeseed oil received, and will be used when present supply of sperm oil is out.

Cay Sal Bank.

Dioptric light and pneumatic lamp. One head and one assistant keeper, who divide the night into two watches—from sunset to midnight and from midnight to sunrise. The keepers are well trained to their present duties. The head keeper keeps a journal of proceedings and of expenditures of stores, &c., which he transmits monthly and quarterly to the collector of the customs at Nassau.

GIBB'S HILL—BERMUDA.

Built of cast-iron; resists the wet very well; painted white; revolving catadioptric light; no interval of darkness within twelve miles; first order lens light. Four concentric wicks; hydrostatic lamp. One keeper and two assistants; keeper £100, each assistant £50 per annum. Upper panes of lantern 4 feet and $2\frac{1}{2}$ feet, centre panes $3\frac{1}{2}$ feet square. Keep a regular journal. One spare lens kept on hand. Each keeper takes his turn at the light house during the day; they are divided into three watches at night. A professional person visits the light-house to inspect the machinery and to superintend repairs. The tower has been struck twice by lightning; no lightning rod attached; the conductor is made of chain, and the lightning is led off from the lower end by four chains, at right angles, to four different tanks of water. A register is kept of wind and weather.

AUSTRALIA—CAPE OTWAY.

Coast light; revolving catoptric light, three faces, seven lamps and reflectors in each. One keeper and two assistants. Ventilated by iron and copper piping. Thermometer, barometer, weathercock and rain gauge are supplied; time by dial. The majority of British colonial lights are fitted with Argand lamps and parabolic reflectors. The Trinity House instructions to keepers are clear, concise and explicit.

BENGAL—FALSE POINT LIGHT-HOUSE.

Coast light. A regular log is kept, and an account of receipts and expenditures of stores. The glasses are kept clean by the watch and ventilated by three chimneys. A watch is kept during the night regularly, and relieved every four hours, whose standing orders are to keep the panes clean, the lamps trimmed, and to report immediately to the superintendent any signals from shipping, by guns, blue lights, or otherwise; also any remarkable change of weather during the day or night; all occurrences reported to the superintendent. A barometer and clock will be supplied. A log is kept in which the winds and weather are noted.

EASTERN CHANNEL LIGHT VESSEL, (HOPE.)

One lantern with eight lamps and reflectors, hoisted on a mast, with blue lights and maroons shown alternately every half hour; visible all around the compass; height from water edge sixty feet; seen at the distance of twelve miles in clear weather, as per Captain Lloyd's survey in 1838. The lantern is octagon; stands the sea and weather very well; diameter fourteen feet. The sea has no effect upon the lantern, nor does the spray fly over it; the panes are $\frac{1}{4}$ -inch thick, more or less; length twenty-four inches and breadth twenty inches; the vessel is supplied with spare glass, in case of accidents. Anchored in eleven fathoms, low water, spring tides, cable according to circumstances, (or wind and weather,) veering from fifty to two hundred fathoms; anchors fourteen hundred weight; coir cables of fourteen inches, tarred; tonnage one hundred and seventy. Crew relieved every six months; one officer on leave occasionally; pilot relieved every two months. Daily log and account of expenditure of stores kept. The

nearest shore is thirty-five miles distant, and that is the wild, jungly part of ——— island. If the oil is good, the smoke is very trifling, and the lantern has a ventilator top and bottom. The panes are free from ice, and everything on board requisite for cleaning the same.

The second officer is to keep the watch from 8 to 12 p. m.; the first officer to keep the middle watch from 12 to 4 a. m., and the master of the vessel to look out from 4 to 6. The two officers change watch alternately, but the master to look out as above stated.

Fog sometimes prevails, and the vessel is provided with two twelve-pounder brass guns and a bell; the guns can be heard at a distance of from eight to ten miles; average number of guns fired per annum from twenty to forty; copper magazine kept in gun room, under hatches. Have a barometer, thermometer and time piece on board. Daily log kept of the wind, weather, barometer, &c., &c.

Shipwrecked mariners have often been relieved by the light vessels, and what is required for their relief is supplied by the commander.

Bengal lower light—light vessel, (beacon.)

The same as the Hope in respect to allowances, apparatus, journals, &c.

Middleton point—floating light vessel.

The instructions to superintendents, keepers, &c., &c., are very explicit.

Return of the expenditures for the year 1850 for four light-houses, two light-vessels, and a spare light-vessel, in the river Humber, under the direction of the Trinity House, at Hull.

Total amount of expenditure for above \$8,700; or an average for each light-house and light-vessel, omitting the spare light-vessel, although including the amount for taking care of it and keeping it in readiness, \$1,450.

For the four light-houses, exclusive of salaries, \$1,325.

Or for each light-house, \$331.

For the two light-vessels and the spare one, \$5,400.

Or for each light-vessel, including expense of spare one, \$2,700.

K—No. 2.

Ventilation of Light-houses.

FARADAY'S TUBES.

Extract from the evidence of Jacob Herbert, Esq., Secretary to the Trinity House Corporation, of London, before the Select Committee on Light-houses, 1845.

Q. Have you not made one great improvement upon the suggestion of Mr. Faraday, with respect to the perpetual and constant current of air in each lantern?

A. That is an improvement which is now in course of application at each establishment; it is not yet carried into operation in all, but it has been applied in some; and where it has been applied, it has been found effective.

Q. Will you explain the nature of that improvement?

A. The improvement in the reflecting lights consists in fixing over each burner an air tube; these several tubes meet in a common tube which has external communication; they are a little curved at the lower part, where they enter the glass cylinder, or chimney, and are placed at about one-eighth of an inch below the upper edge of that chimney; and it is found, by this adjustment, that a current of air is produced, running, in the first instance down into the chimney, and then immediately after altering its course and passing out the tube, is ultimately carried out; so that the vapor produced by the combustion of oil, which is not only injurious to the light, when condensed upon the glass, but is also prejudicial to the human frame, is carried away, and the light-keepers state, in these lanterns where it has been placed, that they can live in and endure the heat of the lantern, which is greatly lessened, without any sort of inconvenience, so greatly is the circulation of pure air permitted by this apparatus.

Q. Is it intended to apply the same means of ventilation to other places?

A. It is intended to apply universally, and it is progressing at this moment.

Q. Has it been applied to the Foreland, where there are two lights?

A. It has.

Q. To both?

A. One is dioptric and the other is catoptric; and though the mode of applying it is different, the principle is in operation at both.

K—No. 3.

FOG SIGNALS.

Extracts from the evidence of A. Gordon, Esq., civil engineer, &c., London, before the select committee on light-houses, 1845.

Q. Have you any suggestions to offer as to the efficiency of the floating lights?

A. I would suggest that in foggy weather the gong or bell should be superseded by the use of a shrill scream or whistle—such as the railway whistle, giving it sound by a bellows, and having the sound directed round the horizon by reflectors similar to those of Bordier Marcet, for reflecting light. The vibration of air follows very much the same lead as the vibration of light; and if a sound is made in the focus between the two reflectors of Bordier Marcet's apparatus, it would be spread equally round the horizon. This apparatus consists of two conoids, with the apex of each cut off; the one erect, the other inverted, and the focal position is in the centre between them. When this apparatus of Bordier Marcet is cut in two, it presents a section of a parabola on one side and a parabola on the other; in other words, a parabola all around. Its form is generated by the revolution of a parabola between the two conoids, when they are so placed. This form has the property of directing all the sounds which impinge upon the para-

bolic lines of the conoid into a horizontal plane all round ; and by this system of reflection, I think sounds from these floating light-vessels could be conveyed a much greater distance than they are at present.

Q. Have you seen experiments made as to the conveyance of sound, in stormy or hazy weather ?

A. I have heard the gong in hazy weather, and I am convinced that the locomotive whistle would be heard much further.

K—No. 4.

DABOLL'S FOG-WHISTLE AT BEAVER-TAIL LIGHT-HOUSE.

Boston, *July 3, 1852.*

SIR: The light-house board specially instructed by the department, have visited the Beaver-tail light-house, and examined the fog-whistle of Mr. Daboll.

The board had a favorable opportunity to witness and judge of the power of the whistle in passing up the sound, on the morning of the 29th ultimo. They left New York on the evening of the 28th, in the steamer Empire City ; the early part of the night was clear, but as the steamer approached the east end of Long Island and the passage between Beaver-tail and Brenton's reef, the fog become so dense that navigation would have been extremely hazardous without some better guide than the compass and lead, and this was found in the whistle, which sent its clear and shrill notes far over the water, indicating the bearing of the point on which it is placed, much more accurately than a bell or a gun would have done, and enabling the steamer to arrive, with little loss of time, at her port. * * * *

The board recommend the expenditure of the appropriation made by Congress for the purpose of placing the whistle at the other points contemplated, and are of opinion that the substitution of horse-power for hand power, is very desirable in all cases which will admit of it. * * * *

Very respectfully, your obedient servant,

W. BRANFORD SHUBRICK,

President Light-house Board.

Hon. W. L. HODGE,

Acting Secretary of the Treasury.

DABOLL'S FOG-WHISTLE.

TREASURY DEPARTMENT,

June 11, 1851.

SIR: An appropriation of \$2,500 in the light-house act of 28th September, 1850, provides for the erection of fog-signals at the light-houses on Execution rocks, Gull island, (Long Island sound,) Beaver-tail point, (Rhode Island,) and on board the light-boat at Bartlett's reef, (Long Island sound.)

Under the authority of the above act, one of Daboll's fog-whistles has been placed on Bartlett's reef light-boat, and is now in operation ; application for a contract to erect the same signal at the three other points named, has been made to the department, and before any action is taken on the

subject, it is desirable to have the opinion of the light-house board based upon an examination of the signal mentioned, as to its relative merits, and the propriety of its adoption at those points.

You are, therefore, respectfully requested to lay the subject before the board, with the wish of the department to be favored with its report at as early a day as may be convenient.

Very respectfully,

THO. CORWIN,

Secretary of the Treasury.

Com. WM. BRANFORD SHUBRICK,

President Light-house Board.

WASHINGTON, June 8, 1851.

SIR: Congress having ordered an appropriation of \$2,500, in September last, (light-house bill, under the head of "Oregon") for fog-signals, &c., I propose to put up, in as good working order as that now at work at Beaver-tail, *three machines* in addition to the one already completed there, viz: one at Execution rock light, one at Bartlett's reef light-ship and one at Gull island—each by hand power.

These machines (together with that at Beaver-tail,) to be completed and put in good working order for the sum of \$2,500, being the amount appropriated for that purpose—that is \$2,500 for the machines at Beaver-tail, (for which nothing has yet been paid) and for three machines to be put up at Execution rock light, Bartlett's reef, and Gull island. As Gull island and Beaver-tail are very important points to commerce, it is proposed by me to put horse-power machines at these *two* points, the same as now at work at Beaver-tail, (instead of hand power, the additional expense not to exceed \$1,000, including the building for their protection,) and for which additional sum of \$1,000 I am willing to await the action of Congress.

The horse-power machine now at Beaver-tail will not cost more to work, per annum, than hand-power, or what is paid for ringing or tending fog-bells, and it has advantages over manual labor, and will at all times insure a greater and more uniform pressure—being heard, as will be proved by vouchers, from two and a half to ten miles.

Respectfully your obedient servant,

C. L. DABOLL.

HON. SECRETARY OF THE TREASURY.

UNITED STATES REVENUE-CUTTER MORRIS,

Harbor of New York, June 3, 1851.

SIR: In obedience to your order under date of the 15th ultimo, directing me to repair to the light-house on Beaver-tail point, at the entrance to the harbor of Newport, and to examine and report to the department my opinion of the utility of the whistle recently placed there as a fog-signal, I have the honor to inform you that I have attended to that duty: On the 29th ult. I proceeded in the revenue cutter Jackson, accompanied by E.

D. Lawton, esq., collector of the port, and the following is the result of my observation.

Near the light-house I found a whistle used as a fog signal, with a reservoir of two hundred and twenty-five gallons capacity—two large air pumps working into this by a crank, connected with which is the arrangement of machinery for the horse-power, and by which arrangement forty or fifty pounds pressure is obtained in about four minutes time. The machinery is exceedingly simple, being destitute of complication, is easily understood, even by the most illiterate.

Besides the whistle, a fog-horn has been attached, which can be used to good advantage as a fog signal on board of light-ships, the machinery being so arranged that it can be detached from the horse-power if necessary. A substantial building is also provided in which the machinery and horses are kept. Every thing seems to have been provided in this building to give certainty and security to this signal. In order to test this signal, we ran several miles outside; the wind at the time was blowing strong from the northeast and across our wake, the sea was rough and the weather windy. We heard the whistle and horn distinctly at a distance of two and a half miles, and I have no doubt but the whistle or horn either could be heard in calm weather from four to five miles outside. I herewith forward you letters from several of the commanders of steam-ships navigating the Long Island sound, asking to have located at Execution rock, Bartlett's reef and Gull island, one of Daboll's fog-whistles; but in place of the fog-whistle at Bartlett's reef light-ship and at Execution rock light-house, I would most respectfully recommend Daboll's fog-horn, to be worked by hand. This would give the navigator a better opportunity to determine his position between Gull island light and the light-ship at Bartlett's reef in thick weather.

I have the honor to be, very respectfully, your obedient servant,

GREEN WALDEN,

Captain United States Revenue service.

To Hon. THOMAS CORWIN,

Secretary of the Treasury.

NEW YORK, May 31, 1851.

SIR: In behalf of the steamboat interest, may I ask of you to use your endeavors to have located at Execution rock light, Bartlett's reef, and Gull island light, the fog-whistle contemplated by the act of Congress of last September, making appropriations for fog-signals, and oblige

Yours, very respectfully,

BENJAMIN BRAYTON,

Master Steamer Empire City.

Captain WALDEN,

United States Revenue Service.

The above recommendations and requests meet with my views upon the subject of fog-signals, and I hope the object above mentioned may be speedily effected.

WM. H. FRAZER,

Master Steamer Commodore.

NEW YORK, *May 31, 1851.*

SIR: I understand that you have been employed by the government to make certain examinations on this coast relative to fog signals, and as an appropriation was made by the last Congress for fog signals at Execution rock, Bartlett's reef, Gull island, and Beaver-tail, I would, in behalf of the navigating interest generally, request your co-operation in having immediately placed at each of these stations one of Daboll's fog-whistles; being fully convinced, from practical experiments which I have witnessed, that the whistle has decided advantages over bells for marine signals.

Very respectfully, yours, &c.,

JEROME WILLIAMS,

Commanding Steamer Connecticut.

Captain G. WALDEN,

U. S. Revenue Service, New York Station.

DAILY NEWS OFFICE,

Newport, June 27, 1851.

SIR: Feeling a deep interest, in common with the whole commercial community, in the success of the new enterprise at Beaver-tail—the air-whistle for the protection of navigation—I take the liberty to state, for the information of the department, that during the dense fogs which have prevailed here quite frequently during the last few weeks, I have repeatedly heard Daboll's air or fog-whistle, at short intervals both during the night and evening, while sitting in my office. The whistle has been most distinctly heard all over town, and even for two or three miles beyond us. Beaver-tail is six miles distant from here. I learn from persons who are entirely reliable, that they have often heard this whistle at even still greater distances.

I have the honor to be, very respectfully, your obedient servant,

W. H. CRANSTON.

HON. SECRETARY OF THE TREASURY,

Washington, D. C.

NEWPORT, RHODE ISLAND, *June 27, 1851.*

SIR: In behalf of the interest of commerce and navigation, I am induced to state, for your information, certain facts concerning Daboll's air or fog-whistle, at Beaver-tail, on this coast. I was for a number of years, say fifteen, keeper of that light, (which is a very exposed situation, and almost always visited with a loud roaring surf breaking in from the ocean,) and during this time the government erected machinery there for ringing a large bell; but this bell could not be heard but a very short distance, and very frequently not outside the breakers. During this time also the steamer Providence ran ashore on this point, when making her passage from New York during a fog, and endangered the lives of many hundred passengers, though fortunately she was got off without serious damage. Since Daboll's air or fog-whistle has been placed there, I have repeatedly heard it during the foggy weather, both day and night, at a distance of from six to eight

miles. I consider it to be the most important invention that has ever been originated for a marine signal, and sincerely hope that our government will immediately take such steps as will insure its incorporation into the light-house service of the United States.

With much respect, your obedient servant,

SYLVESTER R. HAZARD.

We concur in the above suggestion, and attest also that we have heard the air-whistle, during the recent foggy weather, six miles and upwards.

E. GIFFORD, *Captain*.

E. R. Ingraham,
Silor H. Cottrell,
W. G. Peckham,
J. W. Downing,
D. T. Sumbrown,
William Prisneger,
Peleg Hall,
Joshua Fayan,
Peleg Eldred,
G. Woolsey,
Hosea Seviles,

Saml. Allen,
Wm. Gilpin,
W. W. Daly,
R. F. Williams,
Philip Rider,
T. Mumford Seabury,
John H. Watson,
James Harmonson,
Henry Tisdall,
James N. Stevens,
W. S. Newton Allan,

Christopher G. C. Hazard.

Hon. SECRETARY OF THE TREASURY.

WASHINGTON, *June 9, 1851.*

SIR: I beg leave to append this note to the proposals made by me on the 7th instant, (for placing fog-whistles at several points therein specified,) as explanatory of the appropriation ordered by Congress for said purposes.

During last fall, Congress being then in session, I exhibited at New York, a hand-power machine for blowing my air-whistle and fog-horn; after a thorough examination of the same, the collector, Mr. Maxwell; the superintendent of lights, Mr. Coggeshall; the president of the board of underwriters, Mr. Jones; many of the first pilots, packet-masters, &c., together with Mr. Geo. W. Blunt, severally addressed letters to the members of the committee of commerce, and other gentlemen of the House and Senate then in Washington, recommending its adoption on light-houses, light-ships, &c., where it was necessary to see the station before passing it in safety.

Besides these, several ship-owners and pilots testified to the importance of the whistle over the bell, from having previously heard the same blown in the sound at Bartlett's reef, where I had placed a machine for experimental purposes.

Upon such recommendations the act was passed making appropriations for fog signals.

Very respectfully; your obedient servant,

C. L. DABOLL.

Hon. SECRETARY OF THE TREASURY,

Washington.

CUSTOM-HOUSE, NEWPORT,
July 7, 1851.

SIR: In conformity with your directions I proceed to give such information in relation to Daboll's air-whistle as I have been able to collect. It may, perhaps, be proper for me to say that in the outset I did not think very highly of Mr. Daboll's invention, but having witnessed its effects in a more practical way, during the dense fogs that have prevailed of late in this vicinity, I have materially changed my opinion in regard to it.

On Sunday morning, June 15th, I awoke about half past 3 o'clock, (my house is in the centre of the town;) I heard the whistle and trumpet two or three times alternately, immediately on awaking, and continued to hear the whistle at regular intervals of a few moments, from half to three quarters of an hour, at which time the New York steamer arrived at the wharf—the fog was very thick. Two days afterwards I heard it again under precisely the same circumstances, except that my windows were open; on the first occasion they were shut. I often hear it when about the streets, even if there is considerable noise of carriages, &c. A great many of our citizens, well known to me, have testified that they often hear it at times when their attention is otherwise attracted. A Mr. Van Zandt, who lives in Middletown, one mile and a quarter NE. from Newport, hears it very frequently. On the fourth of this month I fell in company with a Mr. Swan, a fisherman of more than ordinary intelligence and respectability; he has for several years been employed by the steamboat companies to blow a horn at dangerous points during foggy weather; he speaks in earnest and decided terms of the utility of the whistle, and says that when he is about his fishing excursions, that being habituated by his employment aforesaid, to listen constantly, he hears the whistle under various circumstances, from five to ten miles distant. Beaver-tail is six miles from Newport. I might adduce much more testimony of the same character, but probably you will consider this sufficient, if not, be pleased to forward your further instructions.

Most respectfully, your obedient servant,

EDWD. W. LAWTON, *Collector.*

TO THORNTON A. JENKINS, U. S. N.,

Secretary to the Board of Light-house Commissioners.

FORT ADAMS, RHODE ISLAND,
June 14, 1851.

DEAR SIR: I take pleasure in stating for the information of any one not acquainted with the *air* or *fog*-whistle, that in your recent trials with it at Beaver-tail light, it was distinctly heard here, and seemed to be quite shrill or loud. We at first thought it the mail steamer's whistle as she was passing the fort.

I have no hesitation in saying that I believe it a most valuable discovery to mariners, as I cannot doubt it will be eventually used as a part of the light-house system of most, if not every maritime country.

I am, very respectfully, your obedient servant,

S. L. FREMONT,
Captain U. S. A.

C. L. DABOLL, Esq.

BEAVER-TAIL LIGHT,
Canonicut Island, October 8, 1851.

To all whom it may concern: this may certify that having kept the light here for nearly four years in my own name, I have never heard the bells when they have been rung at Newport, either on Sundays or other days, while at this point.

Mrs. DERMARIS H. WEEDEN.
 (per her order,) GEO. H. WEEDEN.

JAMESTOWN, *June 11, 1851.*

To all whom it may concern: I have been requested to state the distance and under what circumstances I have heard the air-whistle at Beaver-tail.

I have heard it several times at my residence at the ferry, at Jamestown, which is some five miles distant in a direct line, when the weather was foggy and the wind was blowing across the sound at the time.

JOSEPH W. DOCKRAY,
Formerly second mate of the steamer Connecticut.

DISTRICT AND PORT OF NEWPORT,
Collector's Office, July 7, 1851.

SIR: So much new testimony has been collected within a few weeks in relation to Daboll's air-whistle, and as quite a difficulty exists in finding such persons to examine the subject as alluded to in your letter of the 6th May, I have deemed it proper to write you the results of my own observations and those of our community, in preference to incurring expense that would probably add little to what you already know. Perhaps you may have observed that my report in regard to this subject has not been of a very sanguine character; in fact, I did not think very favorably of the invention, although I considered it worth something; but having witnessed its effects in a more practical way during the dense fogs that have lately prevailed, I have changed my opinion materially. On Sunday morning, June 15th, I awoke about half-past 3 o'clock; my house is in the centre of the town. I heard the whistle and trumpet two or three times alternately, immediately on awaking, and continued to hear the whistle distinctly and clearly, at regular intervals of a few moments, from a half to three quarters of an hour, when the morning steamer arrived from New York; the wind was easterly but light, of course blowing from the town towards the whistle, and my windows were shut. Two mornings afterward, I heard it again under similar circumstances, (except that the windows were open) with still greater clearness; I often hear it in foggy weather in different parts of the town, where there is noise of drays and carriages. Captain Thomas Riddell, a very respectable citizen, formerly a shipmaster and merchant, living about half a mile east from me, states that he often hears the whistle at his house distinctly. Captain Joseph Paddock, the surveyor of this port, and all the inspectors testify the same. Mr. Van Zandt, who lives in Middletown, about $1\frac{1}{4}$ miles further from Beaver-tail light than I do, reiterates the statement. This morning I fell in with a Mr. John Swan, a fisherman, the most respectable of his class, and of good judgment; he has been employed several years by the steamboat companies to blow a horn at

dangerous points in foggy weather; he speaks in earnest and decided terms of the utility of the whistle. He says that when he is about his fishing excursions, being habituated by his employment to listen constantly, he hears it at different times from five to ten miles distance, under various circumstances. Beaver-tail light is six miles from Newport. I have selected these testimonials from hundreds of such as might be obtained of equal authenticity. Mr. David G. Cooke, who went with me in the cutter, will make a written report if desired, but thinks the recent testimonials far more conclusive than those he might give, and you already have the report of Captain Green Walden, who was present on that occasion.

I am, sir, most respectfully, your obedient servant,

EDWARD W. LAWTON,
Collector and Superintendent of Lights.

To S. PLEASANTON, Esq.,
Fifth Auditor of the Treasury.

UNITED STATES REVENUE CUTTER MORRIS,
Harbor of New York, June 3, 1851.

SIR: In obedience to instructions from the Hon. W. L. Hodge, the acting Secretary of the Treasury, in a communication addressed to me on the 3d ultimo, directing me to proceed to Boston and report to the collector, for the purpose of making an examination of the fog-bell lately erected at the outer light in that harbor, on my arrival in the city, on the 12th, and in the absence of Mr. Greely, I reported myself to Mr. Wellman, the deputy collector of the port. Finding that the United States revenue cutter Hamilton had been hauled up for repairs, I hired a small steamer, and, in company with Mr. Wellman, proceeded to the light-house to perform the duty assigned me. In order to test the utility of the bell, and the distance at which it could be heard at sea, we went several miles outside of the light-house while the bell was being rung, with a south wind blowing across our wake and ahead, and while the steamer was under full headway, with the noise of her engine and machinery and the water made by her wheels, and at the bow we heard the bell distinctly at a distance of five miles.

The weight of the bell is 1,375 pounds, and was cast by Messrs. H. N. Hooper & Co., of Boston; it is rung by machinery which runs six hours, striking every forty-seven seconds, with once winding up, which is readily done by one person. The machinery was manufactured at the Lowell machine shop, at Lowell, Massachusetts, and is made in a handsome and workmanlike manner, and does not appear to be liable to get out of order. The structure in which the bell and machinery are enclosed is built of good timber and painted and secured by guys, and I conclude the whole work has been done in a workmanlike manner, very creditable to the contractor. The plan of this bell is much better adapted for a fog signal than any which I have examined.

I forward, herewith, an account in duplicate of my travelling and other expenses.

With high respect, I have the honor to be, sir, your obedient servant,

GREEN WALDEN, *Captain,*
United States Revenue Service.

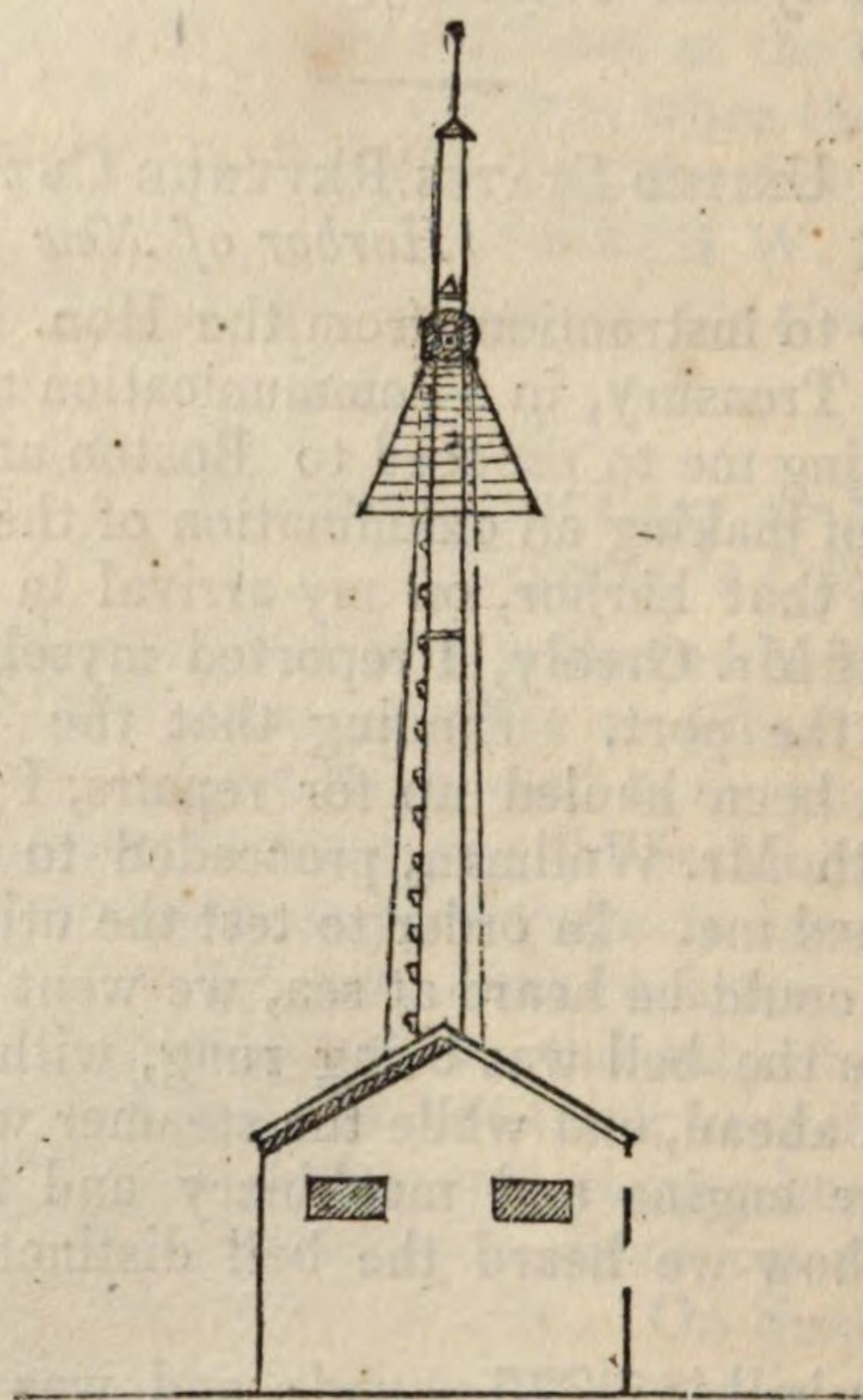
Hon. THOMAS CORWIN,
Secretary of the Treasury.

APPENDIX L—No. 1.

SIGNALS OF THE CAPTAIN OF CORVETTE FÉNOUX, USED ON THE COAST OF FRANCE.

Instructions for mariners, approved by a naval committee.

The FénoUX pilot signal, established on the coast of France, is designed to facilitate the entrance of vessels into port, when storms prevent the pilot from boarding them.



Pilot's signal at rest.

The vane, which has the form of an isosceles triangle, is movable upon its axis, and it is directed on the side on which the vessel is intended to steer. Captains will pay the strictest attention in following exactly and promptly its motions.

A ship coming into the offing from whatever nation, and desirous of using this signal for entering port, will place its colors at one of its mast heads. The pilot will direct the vane in a vertical position, the small side of the triangle being above.

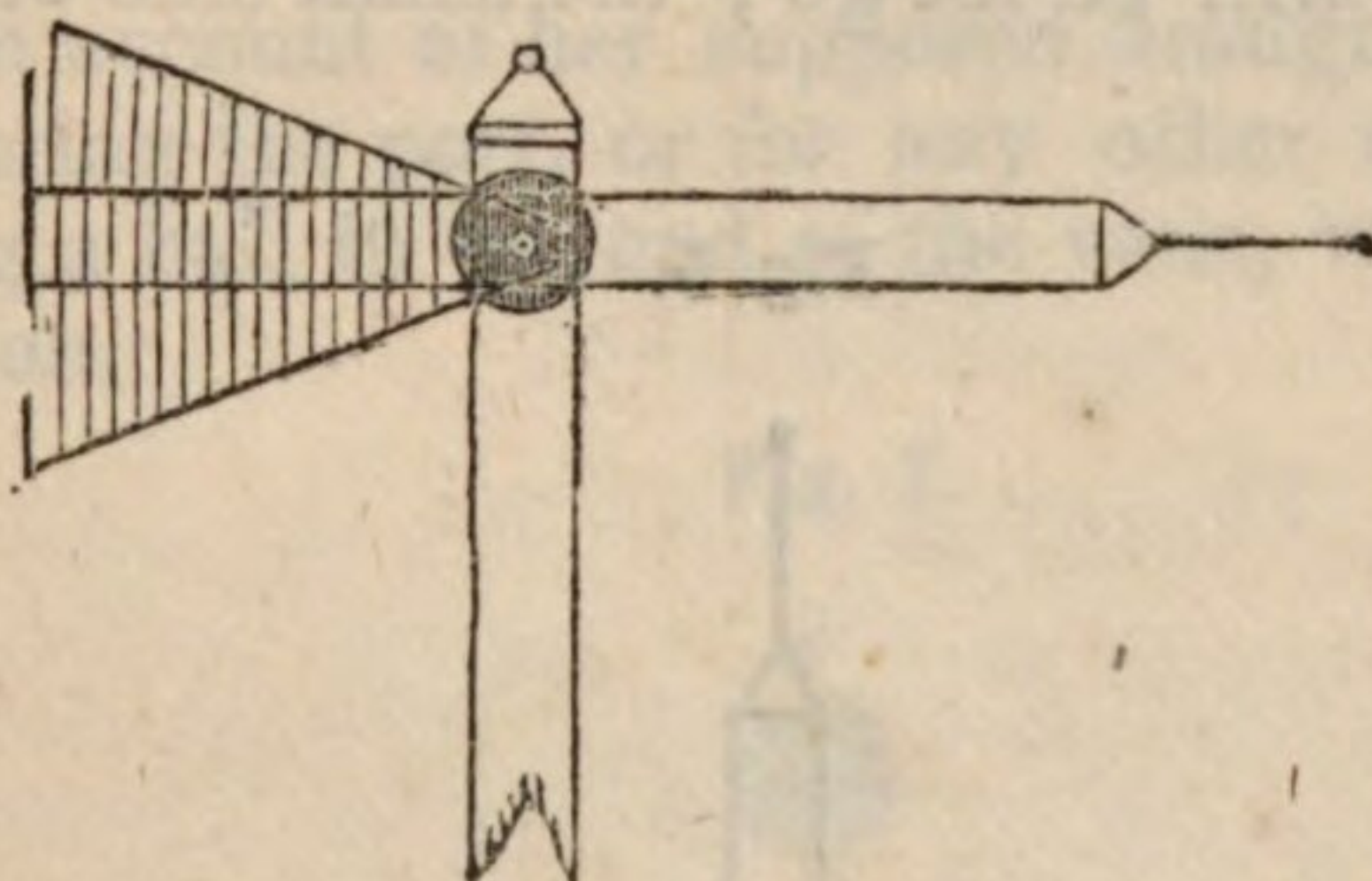
Fig. 1.



The pilot sees the vessel approaching.

Signal that the vessel is seen. Then he will direct it horizontally toward the point for which the vessel should steer for entrance to the channel.

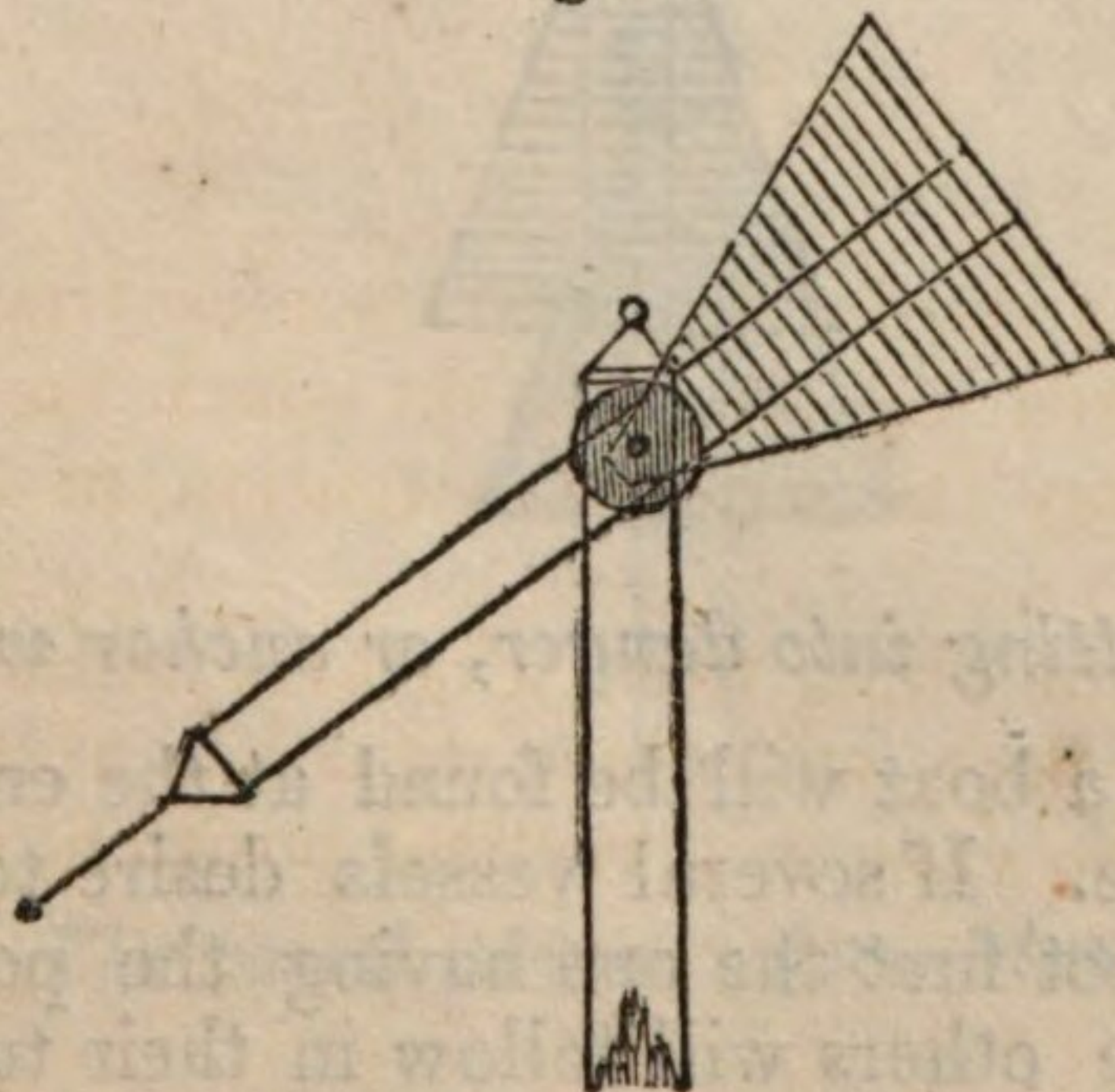
Fig. 2.



Make sail to enter the channel.

Then he will incline it an angle of forty-five degrees either to the right—

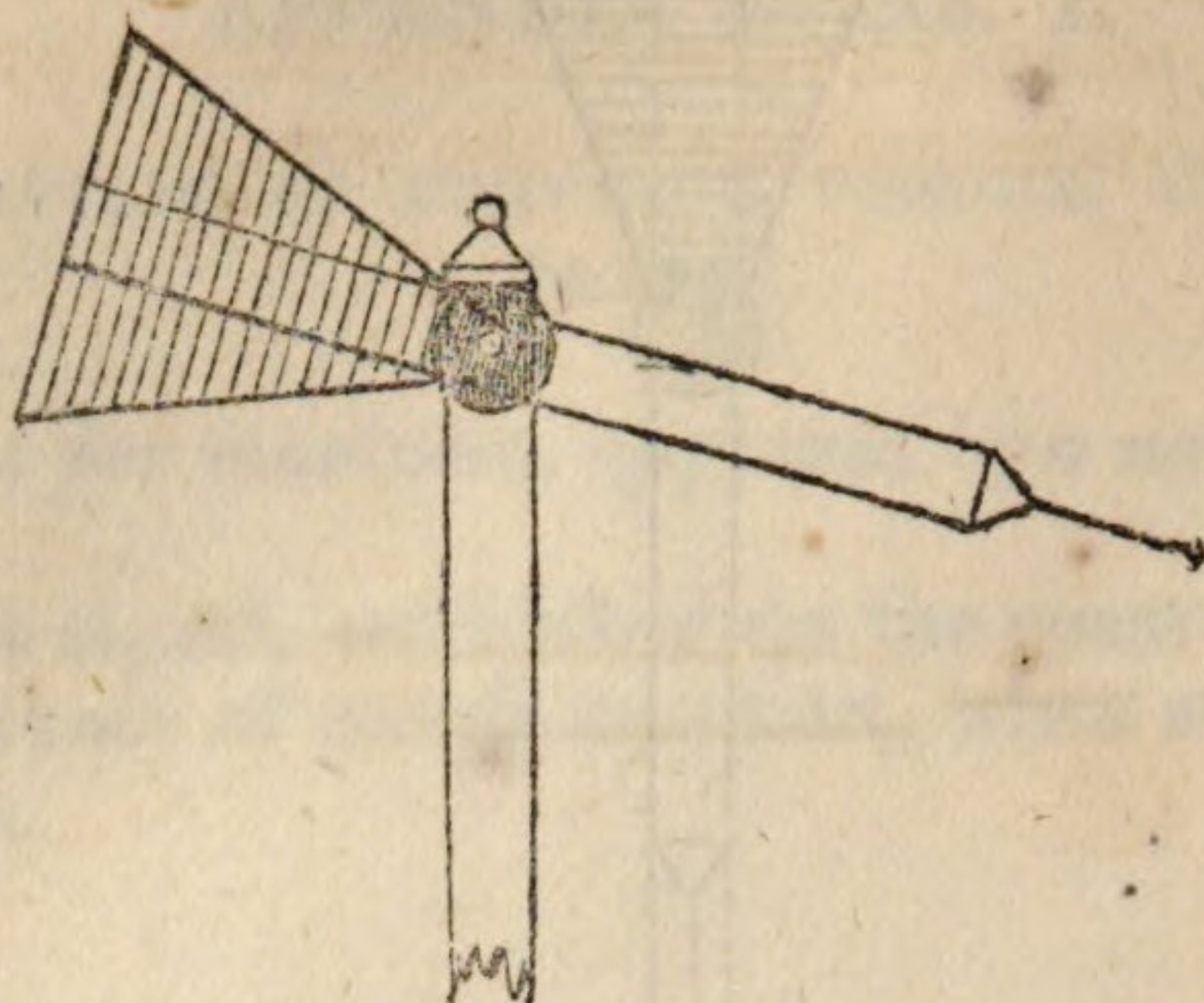
Fig. 3.



Starboard your helm.

Or to the left—

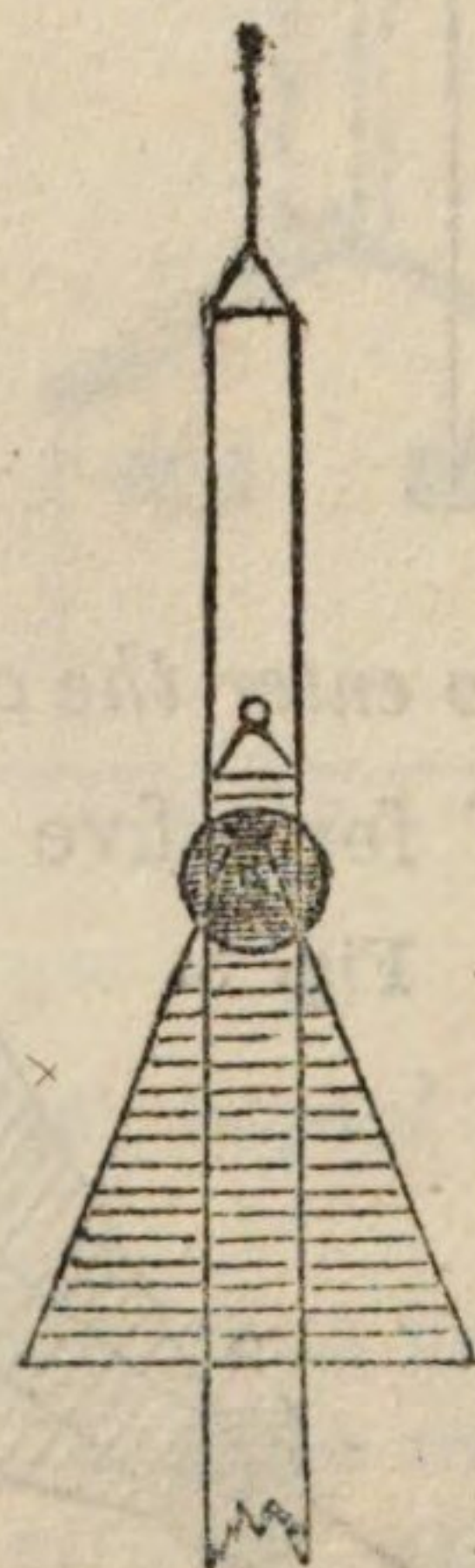
Fig. 4.



Port your helm.

According to the direction he wishes the vessel to take, which must always steer for the side on which the vane is inclined; should put the helm up or down until the pilot stops the evolutions. Directing the vane again vertically (fig. 1,) then the ship will steer the course toward which she was heading when the vane was put in the last position, and will not change her course until a new motion of the triangle shall have so directed. When the ship shall have entered the channel and has no longer need of the aid of the signal, the vane will be let go; the small side of the triangle being below.

Fig. 5.

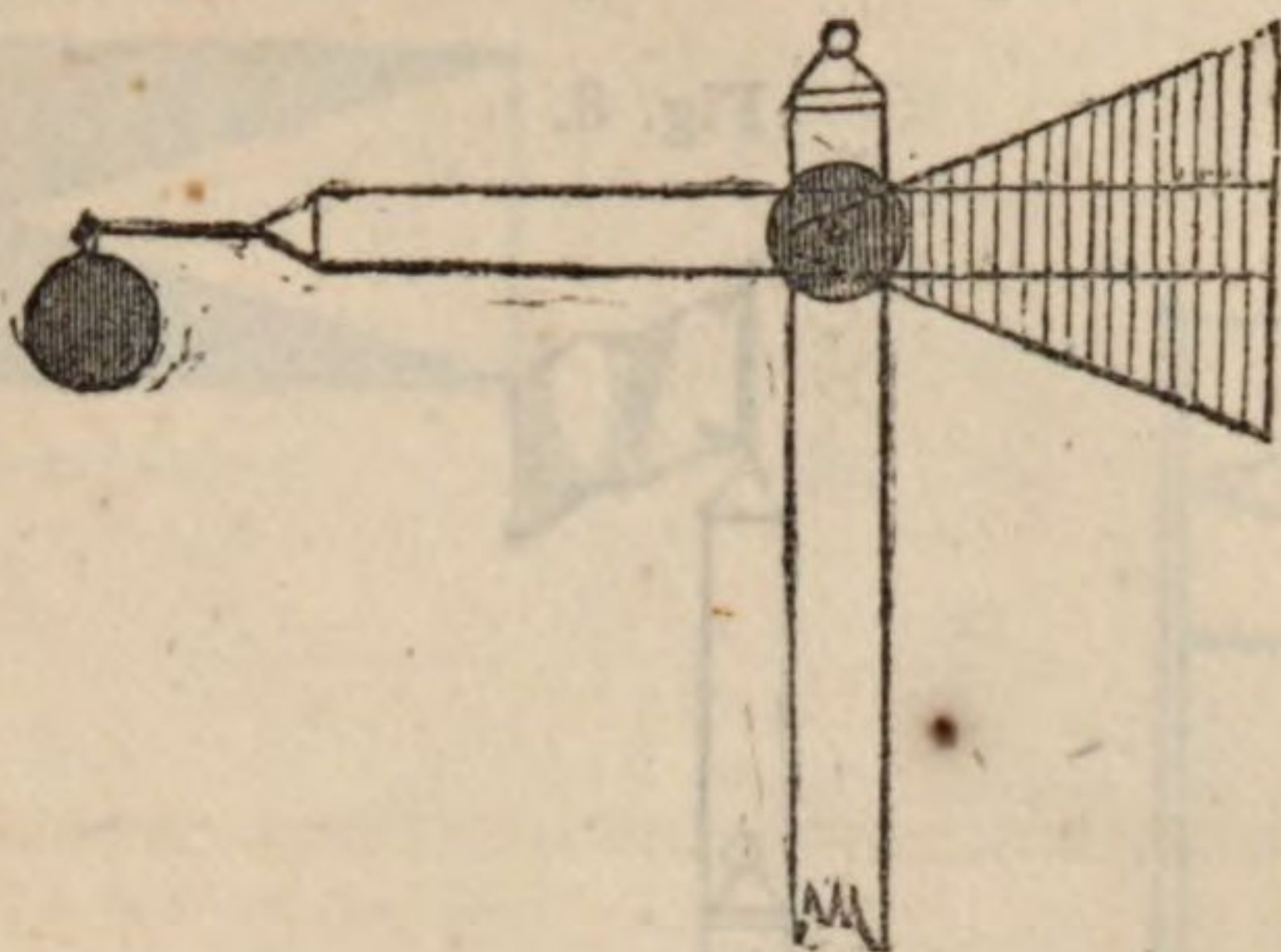


The vessel is getting into danger, or anchor where you are.

And as soon as possible a boat will be found at the entrance of the harbor to take her to anchorage. If several vessels desire to enter at the same time, the pilots will direct first the one having the position for taking the lead in entering, and the others will follow in their turn. But if circumstances should not admit of the vessels entering separately, the captains will steer in the wake of the one directed by the signal, and will keep at

a proper distance from each other so as to follow the motion of the piloted vessel. The pilot, judging that the vessel cannot enter on account of the state of the tide, will place the vane in a horizontal position, and suspend a ball at the end of the vane opposite to the wing.

Fig. 6.

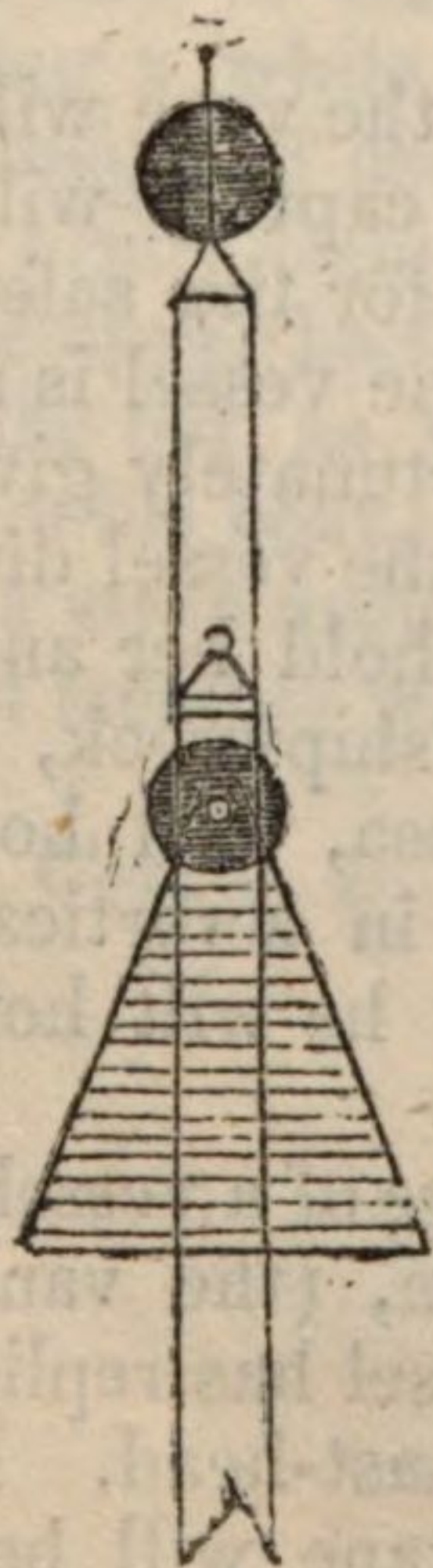


There is not sufficient water yet.

At this signal the vessel will wait until it is directed to enter by inclining the vane to the right or the left (fig. 3 and 4,) as explained above.

When it is seen that a vessel desiring to enter cannot approach land without peril, either on account of her supposed draught, or because the sea is too heavy for entering the port, or for any other cause, warning shall be given by attaching a ball to the end of the vane, which will then be placed in a vertical position.

Fig. 7.



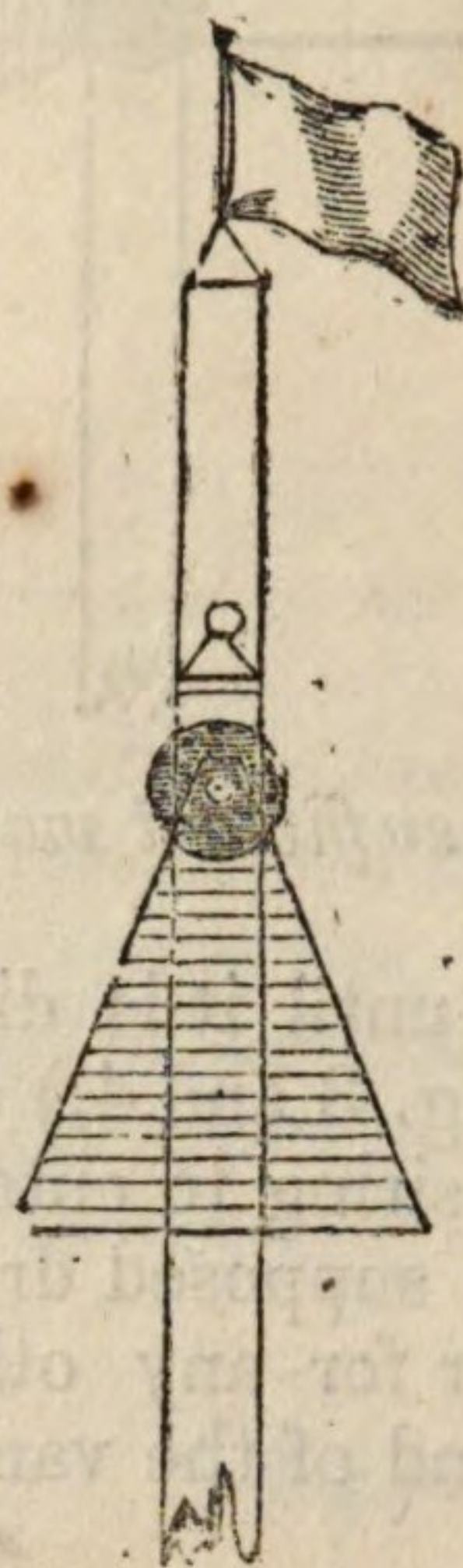
The vessel cannot enter—stand off.

And the vessel will stand off; but if, in consequence of having injuries, or finding herself embayed on a lee shore, she cannot work to windward, and it is decided to enter at all hazards, even at risk of wreck, the vessel will

hoist her flag *enberne*, (that is, tie it in the middle;) then the pilot will direct her to attempt to clear the bar if there be one, or to anchor in the road to wait for a breeze, or direct her to the least dangerous ground for stranding. For anchoring in the road, the pilot will direct her towards the most suitable spot, and when there, the vane placed at rest (fig. 5) will indicate that she should let go one or more anchors where she is.

If stranding is inevitable, the pilot will warn the vessel that she is about to do so by hoisting a red flag on the signal.

Fig. 8.



You are going ashore.

He will keep this flag up, while the vane will perform its motions to direct the vessel towards land, and the captain will take all measures customary under such fearful circumstances for the safety of the vessel and especially for that of the crew. If while the vessel is steering for the shore, an unforeseen circumstance should fortunately give the pilot hope of saving her, the red flag will be struck, and the vessel directed as the case may require.

A vessel which can no longer hold her anchors in a dangerous road, and which shall see the certainty of shipwreck, in the case where she cannot enter the port or stand out to sea, will hoist her flag *enberne*, and the pilot, after having put the vane in a vertical position, (fig. 1,) will direct her according to circumstances; he will hoist the red flag on the signal if he is about to strand her.

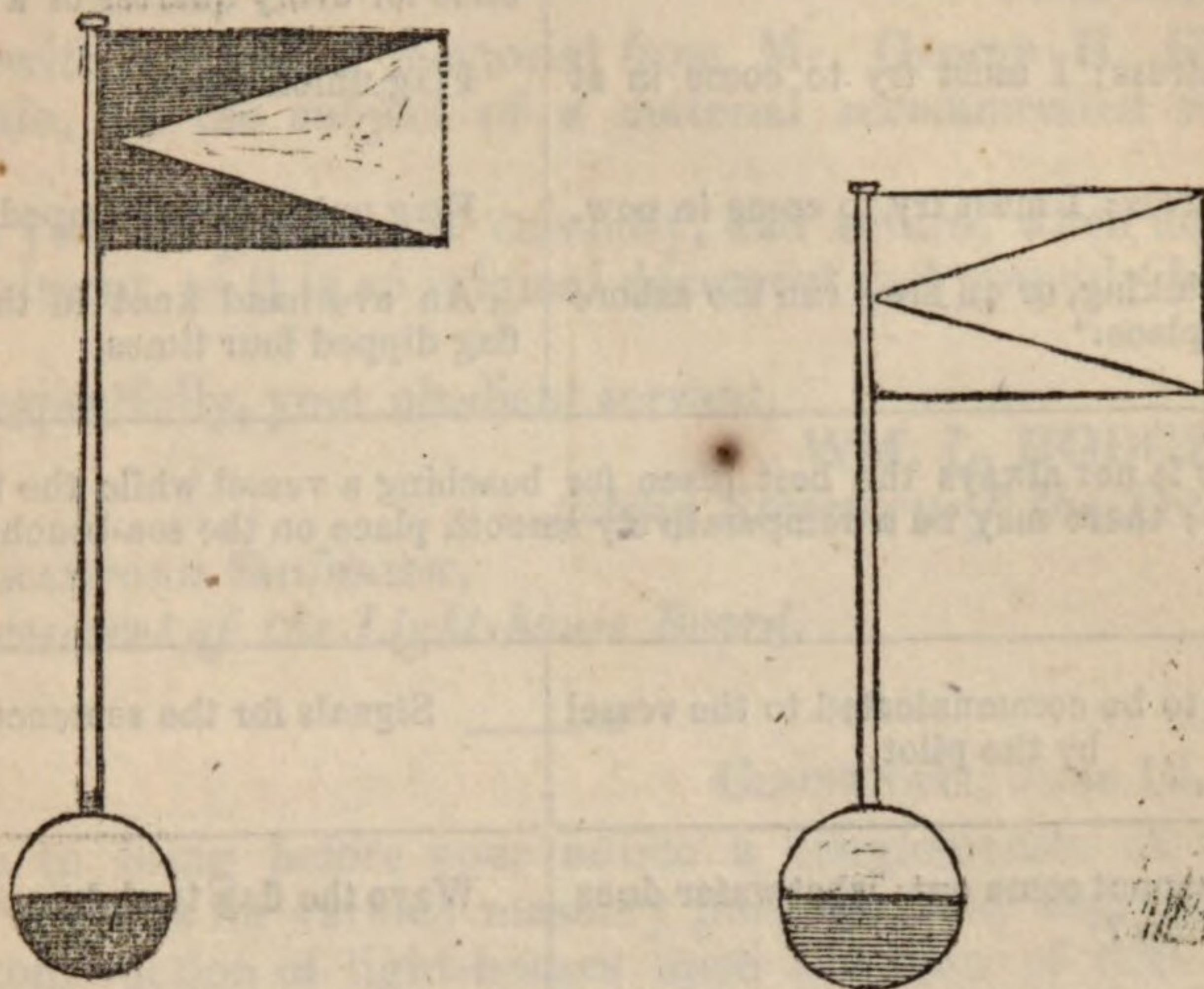
The pilot judging the anchorage of a vessel in the roads should be changed, will make the signal of attention, (the vane in the vertical position,) and maintain this signal until the vessel has replied by a signal of recognition, by placing her colors at her mast-head. If several vessels should be at the same time at anchor, the vane will be kept vertically until the one addressed shall have hoisted her colors. Captains should pay attention not to make their signals at the same time, to avoid confusion and mistake.

FENOUX,

Captain of corvette.

January 5, 1841.

L—No. 2.

TABLE OF SIGNALS FOR PILOTING VESSELS INTO BARRED HARBORS, BY LIEUT.
JOHN RODGERS, U. S. N.*The pilot's flag,*

To be seven feet by six in size, and to consist of two triangular pieces of red muslin or bunting, enclosing a white triangle of the same material, fastened to a staff twelve feet long and one inch in diameter. The end of the staff to have a barrel hoop firmly lashed to it, and have stretched over the hoop a piece of muslin, the upper half white and the lower half black.

The pilot boat to approach the bar as nearly as she safely can. The pilot lays on his oars, or anchors his boat. The boat should be fitted with an awning stauncheon aft, and a strap around it for the pilot to make himself fast to it, that he may stand steadily while signaling.

JOHN RODGERS,

Lieut. Com'g. U. S. navy, ass't. Coast Survey.

Sentences to be communicated to the pilot by the vessel.	Signals for sentence opposite.
1. The vessel wants a pilot.	Jack at the fore.
2. I indicate my draught.	Dip the flag once for every foot which the vessel draws, and run it half up, and dip it once for every quarter of a foot.
3. In distress; I must try to come in at high water.	Flag union down.
4. In distress; I must try to come in now.	Flag union down, dipped four times.
5. I am sinking, or on fire; run me ashore in the best place.*	An overhand knot in the middle of the flag dipped four times.

* The bar is not always the best place for beaching a vessel while the breakers are very heavy on it; there may be a comparatively smooth place on the sea-beach.

Sentences to be communicated to the vessel by the pilot.	Signals for the sentences opposite.
1. Pilot cannot come out; what water does the vessel draw?	Wave the flag to right and left.
2. Not water enough on the bar until high tide.	Pilot raises the flag over his head and dips it towards the vessel once for every hour she must wait.
3. The vessel cannot enter until the wind changes.	Flag and ball horizontal; staff held by the middle.
4. Not water enough on the bar; seek another port.	Waves black and white ball to right and left.
5. Vessel cannot cross the bar until the sea goes down.	Ball inclined 45 degrees to the horizon; flag in left hand as pilot faces the vessel, and staff in right hand.
6. The vessel may get under-way and stand for the bar.	Pilot holds the flag erect over his head, and keeps it so until the vessel weighs; he may incline it the way he wishes her to cast.
7. Steer the vessel to starboard, or port the helm.	Incline the flag to starboard. (In both of these signals the flag points out the side to which the vessel must steer.)
8. Steer the vessel to port, or starboard your helm.	
9. Steady, or steer as you go.	Dip the flag out of sight.
10. Steer for the pilot boat.	Flag overboard; staff upright.
11. Anchor.	Ball over head; flag in pilot's hand.

APPENDIX M.

PROPOSITION OF MR. GEORGE H. KNIGHT TO INTRODUCE CONGLOMERATE FOR LIGHT-HOUSE TOWERS.

TREASURY DEPARTMENT,

June 18, 1851.

SIR: I herewith enclose a memorial from Mr. George H. Knight, of Cincinnati, Ohio, on the subject of a material recommended for light-houses.

I will thank you to preserve it carefully, and return, when done using it, to the department, as it is an original document and properly belongs to the files.

Very respectfully, your obedient servant,

WM. L. HODGE,

Acting Secretary of the Treasury.

Com. W. BRANFORD SHUBRICK,

President of the Light-house Board.

CINCINNATI, June 12, 1851.

SIR: I wish to bring before your notice a conglomerate of stone and iron, which is adapted for various masonry purposes, and especially applicable to the construction of light-houses upon the plan of that upon the Eddystone rock in the English channel, and that upon the Bell rock, off the coast of Scotland. These light-houses have proved so thoroughly satisfactory in positions exposed to the full sweep and power of the sea, that I have thought a similar plan would probably be adopted in the re-erection of a light-house upon Minot's ledge, off Boston harbor.

I take the liberty of referring you to the accompanying drawing, in which is represented a section of the Eddystone light-house, showing the manner in which the stones were interlocked and fastened, to give the whole structure as much as possible the strength of a solid mass. Various works on civil engineering enter at large into the details of its erection.

The peculiar value of my improved conglomerate as a substitute for stone is, that while it possesses a large amount of cohesive strength, it can, at a moderate cost, be made to assume any form that may be required for the structure. It is formed by placing broken granite (previously gradually heated) in a mould of the desired form and pouring in molten metal, (say iron) which fills every interstice between the stones and around them, the iron having a continuous, reticulated or honey-comb structure, and forming a bond of union for the stone.

By a reference to the shape of the stones employed in the construction of the above mentioned light-houses, it will be seen how peculiarly this plan is adapted for obtaining blocks of the dovetailed form, by which each circle of stones is made to interlock with those beyond and within it. I do not deem it necessary to enter here into the details of the various devices adopted for securing the stones to each other, and the layers of stone to those above and beneath them; but I would mention that, in the process of treenailing and joggling the different layers to those above and beneath them, great facilities are afforded in my plan by the introduction of cores

for making the necessary apertures and recesses, as well as in forming the grooves for the wedges which dowell the stones to those adjacent on the same plane.

The expense of dressing up stone (granite especially) to such a shape, and forming the requisite apertures, recesses and grooves in the stones, is a very large item in the expense of erecting such structures.

The following are a sufficient approximation to correctness to assist in a comparison of cost:

One cubic foot of conglomerate weighs about 300 pounds;

Of which there is of granite 150 pounds, forming $\frac{3}{4}$ cubic foot;

iron 150 " " $\frac{1}{4}$ " "

—

Together-----300 " " 1 " "

Rejecting odd numbers there are in the Eddystone 13,000 cubic feet of masonry (13,147.) The building cost about £21,000. If the masonry cost \$78,000 it would amount to six dollars per cubic foot. Estimating the iron in the conglomerate at twenty dollars per ton of 2000 pounds, and the broken granite at six dollars and sixty-six cents per ton, the cost of the conglomerate would be two dollars per cubic foot. The cost of putting up would be additional to this.

The accompanying drawing is from one of Smeaton's original designs as given by Nicholson (P. ;) the outer casing of moorstone granite he subsequently reduced in thickness on account of the enormous cost of working this material, and the granite in some parts of the light-house is only nine inches thick; the Portland stone, of which it is mainly composed, is liable to the attacks of a marine animal, and it was therefore necessary to encase it. It is inferred by Nicholson that granite would have been used for the entire structure, were it not for the great labor and expense of working it.

The same plan was followed by Stevenson in the erection of the Bell Rock light-house, which was built of red sandstone cased with Aberdeen granite. There were 28,530 cubic feet of stone employed, and the cost was £61,331 9s. 2d.; showing a greater proportionate cost per cubic foot than the Eddystone. Several authorities, in speaking of the latter, say that the masonry has never cost anything for repairs since the date of its erection, 1759.

The power of iron to resist a crushing weight is to that of granite as thirteen to one (Rennie;) and in their relative tensile strength, the disproportion in favor of iron is still greater. The object of Smeaton in building up the twenty-fourth course solid (with the exception of a well for the staircase extending from the fourteenth to the twenty-fourth) and a doorway to same, was to oppose, as high as the level of the unbroken waves, a solid mass, whose dead weight or inertia should be sufficient to resist all the disturbing force of the waves. This conglomerate is one-half heavier than granite, and would therefore fulfil this requirement even more effectually than the combination of Portland stone and granite, of which the Eddystone is composed. The effective value of dove-tailing depends upon the cohesive power of the material, and in this respect the metallic element of the conglomerate imparts a strength much exceeding any to be found in any non-metallic mineral.

The diameter of the first entire course (seventh) of the Eddystone is twenty-five feet (Nicholson) for such a structure; therefore there is abundant exposed area on Minot's Ledge.

It is very important in the construction of light-houses in exposed situations, that advantage should be taken of spells of fine weather, low or neap tides, &c.; and a plan which receives such a facility of construction as mine, derives no slight recommendation from that source.

It is difficult to conceive of a situation more exposed and more trying than that of the Eddystone, with deep water close to the rock and the unbroken waves of the Atlantic breaking full upon it. The lantern is seventy feet from the base of the structure, and is said to be frequently submerged by the waves.

In the construction of sea-walls, breakwaters, wharves and piers and such structures, where, from the exposed situation, it becomes necessary to provide a security over and above what is derived from the weight of matter and its power of resisting compression, I believe that my blocks of conglomerate will be found to answer a valuable purpose, as they may be made with salient and receding faces, dove-tails, &c., by which, when placed in position, they are mutually sustaining; while by the introduction of cores they afford any facility for additional clamping or cramping in the usual manner.

I would further mention other uses, but the present object in introducing it to your notice is the probable action of your department in the re-erection of a light-house upon Minot's Ledge, and similar structures in future, whose exposed situation renders a certain amount of cohesiveness and unity in the mass necessary for their permanent security.

I refer you to the Patent Office for a specimen of the conglomerate, which was filed on my application for letters patent, which were granted April 1, 1851. I would mention that it is but a hurried specimen.

I have the honor to be, yours most respectfully,

GEO. H. KNIGHT.

To the Hon. THOMAS CORVIN,
Secretary of the Treasury.

M—No. 1.

Report on Mr. George H. Knight's proposition to introduce conglomerate of stone and iron into light-house structures.

The committee report that they are not prepared to recommend the adoption of the material described in this paper.

They do not say that the idea therein presented, may not either in its present form, or under some modifications, be applicable with advantage in some constructions, but they think that before it be depended upon in so difficult and important a work as a light-house standing in the sea, the material should be thoroughly tested, by trial and exposure, elsewhere, on all the points upon which doubts may be founded.

Respectfully submitted,

JOS. G. TOTTEN,

Brevet Brigadier-General and Chief of Engineers.

JAMES KEARNEY,

Lieutenant Colonel Topographical Engineers.

Adopted.

M—No. 2.

FRANCE.

Extract from Parliamentary report, 1834.—Light-house service of France.

The light-houses, for the most part, existing on the coast of France before the revolution, had been built and were managed by commercial bodies.

A law of the National Assembly, dated the 15th September, 1792, centralized the light-house, beacon, buoy, and sea-mark service, by placing it under the superintendence of the Minister of Marine, and by charging the Minister of the Interior with the execution of the works agreed upon for this service by the two departments.

A consular order, dated the 11th June, 1802, confirmed the law of 15th September, 1792, concerning light-houses.

An imperial decree of the 7th March, 1805, caused the light-house, buoy, sea-mark, and beacon service to be attached to the official duties of the Minister of the Interior, and from that time they were placed under the immediate direction of the commissioners of roads and bridges. This decree, nevertheless, requires the Ministers of the Interior and of Marine, to advise with each other in reference to the establishment of any new light-houses or sea-marks; and this arrangement gave rise to the light-house commission, which was established in 1811.

In 1825, at which period the system of lenticular lights was definitely adopted for lighting the coast of France, this commission is found to have been composed as follows:

M. Becquey, councillor of State, director general of roads and bridges, president of the commission.

M. De Prony, inspector general of roads and bridges, member of the institute.

M. Tarbé de Vaux Clairs, inspector general of roads and bridges, councillor of State.

M. Sparkin, inspector general of hydraulic works at the seaports.

M. Rolland, inspector general of naval architecture.

M. Halgar, rear admiral and councillor of State.

M. De Rossel, rear admiral, director of the repository of charts and plans of the royal navy, member of the institute.

M. Beautemps Beaupré, hydrographer-in-chief of the royal navy, member of the institute.

M. Arago, astronomer, member of the institute.

M. Mathieu, do. do. do.

M. Fresnel, (late Augustin,) principal engineer of roads and bridges, member of the institute, secretary of the light-house commission.

It was by this commission that all the projects and measures adopted since its institution for the improvement of the light-house and sea-mark service were examined and discussed, and one of its most important labors was the study and examination of the general system adopted in 1825, upon the report of rear admiral de Rossel, for lighting the coasts of France.

Present organization of the light-house service.

The organization of the light-house service of France, now in force, is briefly as follows :

This service is attached to the official duties of the minister secretary of state for the department of the interior, and is altogether under the direction of the councillor of state, charged with the general administration of the roads and bridges.

In each naval district, the prefect, principal engineer, assistant engineers, and the superintendents of ponts et chaussées, direct or supervise, in the sphere of their respective offices, all that relates to the management of light-houses, sea-marks and beacons in the neighborhood.

The light-house service, considered collectively, embraces lighting, reparatory works, and the formation of new establishments.

Reparatory works.—The repair or restoration of light-houses, after being authorized by the director general is, with the roads and bridges works, executed under the superintendence of the district administration.

New establishments.—In the formation of new establishments, the following routine is observed :

The engineers of the district where the new edifice is about to be erected, make a draught of the plan, in conformity with the basis previously determined on by the light-house commission.

This plan is forthwith submitted to the commission, which confines itself to the inquiry as to whether the wants of the service, nautically or otherwise reported on, and constituting the main objects, have been complied with.

It is then presented to the council of roads and bridges, to receive their estimate, founded on the reports made of the architectural arrangements of the system of building, and of the calculated expense. After receiving the approbation of the director general of roads and bridges, and of the minister of the interior, the plan is sent to the prefect of the district, who proceeds to the public adjudication (contract) of the works, and intrusts the engineers with the execution of them.

The lamps and light apparatus are made at Paris, under the care of the engineer-in-chief, secretary to the light-house commission.

The establishment of new light-houses is announced to the public two or three months beforehand, by means of bills and advertisements inserted in the maritime newspapers.

The administration, moreover, publishes annually a summary description of the light-houses and lights on our coasts, and causes five or six thousand copies to be distributed among French and foreign navigators.

The whole of the expenses (with the exception of the cost of lighting a very small number of lights of purely local interest) connected with the light-house service, are supplied from the public treasury. The administration of the customs of France does not levy any special light-house duty upon maritime commerce. This duty, which was abolished by the law of the 18th October, 1793, is at the present time compounded with the tonnage duty, which all vessels pay upon their arrival in port.

LOR. FRESNEL,

Secretary of the light-house commission.

PARIS, April 30, 1834.

List of the French Light-house Commission in 1851, instituted April, 1811.

The minister of public works, or in his absence the under secretary of state, presides during the sittings of the commission.

M. Arago, Commander in the legion of honor, representative of the people, member of the institute and of the bureau of longitudes.

M. Mathieu, Knight in the legion of honor, member of the institute and of the bureau of longitudes.

M. Mathieu, Commander in the legion of honor, rear-admiral.

M. De Hell, High officer in the legion of honor, rear-admiral *en retraite*.

M. Leroux, Commander in the legion of honor, general inspector of maritime engineering.

M. Tretté de Laroche, Officer in the legion of honor, divisionary inspector of bridges and roads, charged with the general inspection of maritime works.

M. Fresnel, Officer in the legion of honor, divisionary inspector of bridges and roads, *en retraite*.

M. Reynaud, Knight in the legion of honor, chief engineer of bridges and roads, secretary.

M—No. 3.

List of the Trinity-house Board, London.—Elder Brethren in 1851.

Duke of Wellington, K. G., Master.

Captain Sir J. H. Pelly, Deputy master.

Captain Aaron Chapman.

Right Hon. Lord Viscount Melville, K. T.

Captain Robert Welbank.

Captain John Hayman.

Captain Henry Nelson.

Admiral Sir T. Byam Martin, G. C. B.

Captain Charles Weller.

Right Honorable Sir J. R. G. Graham, Bart.

Right Honorable Earl of Minto, G. C. B.

Captain Frederick Maden.

Admiral Sir Charles Adam, K. C. B.

Captain Stephenson Ellerby.

H. R. H. Prince Albert, K. G.

Captain George Probyn.

Captain William Pixley.

Captain Charles Farquharson.

Captain Robert Gordon, R. N.

Captain William E. Farrer.

Captain Henry Bonham Box.

Right Honorable Earl of Haddington.

Most Honorable Marquis Dalhousie.

Captain John Shepherd.

Captain Edward Foord.

Captain Gabriel J. Redman.

Right Honorable Lord J. Russell, M. P.

Captain John Fulford Owen.

Captain David James Ward.

Right Honorable H. Labouchere, M. P.

Captain Wm. Pigott.

Jacob Herbert, esq., Secretary.

N—No. 1.

An act making appropriations for light-houses, light-boats, buoys, &c., and providing for the erection and establishment of the same, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the following appropriations be, and the same are hereby made and directed to be paid out of any money in the treasury not otherwise appropriated, to enable the Secretary of the Treasury to carry the provisions of this act into effect: *Provided, however,* If a good title to any land which it may be necessary to use cannot be obtained on reasonable terms, or the exclusive right to such land cannot be acquired by cession, when the interest of the United States demands it, before the appropriation would by law fall into the surplus fund, in any and all such cases the appropriation shall be applicable to the objects for which they are made at any time within two years after the first meeting of the legislature, in any State wherein such land may be situated, subsequent to the passage of this act, to wit:

* * *

SECT. 2. *And be it further enacted,* That if such person as the Secretary of the Treasury shall designate shall report, in any of the cases herein provided for, that preliminary surveys are necessary to determine the site of a proposed light-house or light-boat, beacon, or buoy, or to ascertain more fully what the public exigency demands, the Secretary of the Treasury shall thereupon direct the superintendent of the survey of the coast of the United States to perform such duty on the seaboard, and the colonel of the corps of topographical engineers to perform such duty on the northwestern lakes.

SECT. 3. *And be it further enacted,* That the officers so directed shall forthwith enter upon the discharge of the duty, and after fully ascertaining the facts, shall report: First, whether the proposed facility to navigation is the most suitable for the exigency which exists; second, where it should be placed if the interests of commerce demand it; third, if the thing proposed be not the most suitable, whether it is expedient to make any other kind of improvement; fourth, whether the proposed light has any connexion with other lights, and if so, whether it cannot be so located as to subserve both the general and the local wants of trade and navigation; and fifth, whether there be any, and if any, what other facts of importance touching the subject.

SECT. 4. *And be it further enacted*, That all such reports shall, as speedily as may be, be laid before the Secretary of the Treasury, and if such as to authorize the work without further legislation, he shall forthwith proceed with it, otherwise such reports shall be laid before Congress at the next ensuing session; but in all cases where the person designated by the Secretary of the Treasury, under the second section of this act, does not

report such preliminary examination as expedient, the provisions of its act shall without delay be carried into execution.

SECT. 5. *And be it further enacted*, That the salary of the keeper of the Minot's ledge light shall hereafter be at the rate of one thousand dollars per annum, and the assistants five hundred and fifty dollars per annum.

SECT. 6. *And be it further enacted*, That in case it should be impossible, in the opinion of the colonel of the topographical corps, to obtain a perfect title to the necessary land upon which to build the light-house heretofore ordered to be built at the mouth of the Calumet river, on Lake Michigan, said land shall be appraised by three disinterested persons under oath, and the light-house shall immediately be built, and the appraised value of said land shall be paid to any person who shall make to the United States what the Attorney General shall consider a perfect title thereto.

SECT. 7. *And be it further enacted*, That hereafter, in all new light-houses, in all light-houses requiring new lighting apparatus, and in all light-houses as yet unsupplied with illuminating apparatus, the lens or Fresnel system shall be adopted, if, in the opinion of the Secretary of the Treasury, the public interest will be subserved thereby.

SECT. 8. *And be it further enacted*, That the Secretary of the Treasury be, and he is hereby authorized and required to cause a board to be convened at as early a day as may be practicable after the passage of this act, to be composed of two officers of the navy, of high rank, two officers of engineers of the army, and such civil officer of high scientific attainments as may be under the orders, or at the disposition of the Treasury Department, and a junior officer of the navy to act as secretary to said board, whose duty it shall be, under instructions from the Treasury Department, to inquire into the condition of the light-house establishment of the United States, and make a general detailed report and programme to guide legislation in extending and improving our present system of construction, illumination, inspection, and superintence: *Provided*, That no additional compensation shall be allowed any person serving on said board.

SECT. 9. *And be it further enacted*, That the President be, and he is hereby required to cause to be detailed from the engineer corps of the army, from time to time, such officers as may be necessary to superintend the construction and renovating light-houses.

Approved March 3, 1851.

N—No. 2.

Law regulating the manner of marking and coloring buoys.

SECT. 6. *And be it further enacted*, That hereafter all buoys along the coast, or in bays, harbors, sounds or channels, shall be colored and numbered, so that passing up the coast or sound, or entering the bay, harbor or channel, red buoys with even numbers shall be passed on the starboard hand; black buoys with even numbers on the port hand; and buoys with red and black stripes on either hand—buoys in channel-ways to be colored with alternate white and black perpendicular stripes.

* * * * *

Approved September 28, 1850.

An act for the establishment and support of light-houses, beacons, buoys, and public piers.

SECT. 1. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That all expenses which shall accrue from and after the fifteenth day of August, one thousand seven hundred and eighty-nine, in the necessary support, maintenance and repairs of all light-houses, beacons, buoys, and public piers, erected, placed or sunk before the passing of this act at the entrance of or within any bay, inlet, harbor or port of the United States, for rendering the navigation thereof easy and safe, shall be defrayed out of the treasury of the United States: *Provided, nevertheless,* That none of the said expenses shall continue to be so defrayed by the United States after the expiration of one year from the day aforesaid, unless such light-houses, beacons, buoys, and public piers shall in the meantime be ceded to and vested in the United States by the State or States respectively in which the same may be, together with the lands and tenements thereunto belonging, and together with the jurisdiction of the same.

* * * * *

SECT. 3. *And be it further enacted,* That it shall be the duty of the Secretary of the Treasury to provide by contracts, which shall be approved by the President of the United States, for building a light-house near the entrance of the Chesapeake bay, and for rebuilding, when necessary, and keeping in good repair, the light-houses, beacons, buoys, and public piers in the several States, and for furnishing the same with all necessary supplies, and also to agree for salaries, wages, or hire of the person or persons appointed by the President for the superintendence and care of the same.

* * * * *

Approved August 7, 1789.

Shipwrecks on Florida Reefs.

KEY WEST, December 31, 1850.

SIR: I would respectfully submit to my employers my usual report, and a condensed report for the past six years, with such brief remarks upon the passing affairs of this part of the United States as will be interesting to commercial men.

The number of vessels that have put into this port in distress, and been ashore on the reef in the past year, is thirty.

Estimated value of vessels and cargoes	\$929, 000
Amount of salvage	122, 831
Amount of expenses	77, 169
	1, 129, 000

Condensed report for six years.—Number of vessels under the head of marine disasters that have been reported by me, 209.

Value of vessels and cargoes (low estimate)	\$6, 602, 000
Amount of salvage	647, 775
Amount of expenses	259, 637
	7, 509, 412

There has nothing occurred out of the usual course of events since my last report.

The light on Carysfort reef will not be finished for some time.

Government is building a light-house on Sand Key, near this place.

Fort Taylor is now safe from hurricanes, as the foundation is finished, and it is now being filled up.

The government works at the Tortugas are progressing.

There are, in my opinion, more vessels and men in the wrecking business than are necessary.

The population of the island is increasing, and unless business should increase, there must soon be a large number of unemployed persons.

In my last report I glanced at the value of this as a naval station. I have not changed my views. This port ought to be looked after by government. It is a very important point, and when the Tehuantepec canal or railroad and other connections are completed to the pacific, with the increase of commerce that must follow, Key West, the only port of safety for vessels of a heavy draft from Pensacola to Cape Henry, should be protected.

Respectfully your obedient servant,

JOHN C. HOYT.

ELLWOOD WALTER, Esq.,

Secretary board of underwriters, New York.

A statement of vessels wrecked on the Florida reefs, and also of vessels having put into the port of Key West in distress, from the 1st of January to the 31st December, 1850.

Date.	Name of vessel.	Hailing from.	Capt's name.	Where from.	Bound for.	Amount of salvage.	Amount of salvage and expenses.	Value of vessel and cargo.	Remarks.
Jan. 2	Brig Ellen Maria.....	Augusta.....	Hoyt.....	New York..	Mobile.....	.....	\$1,600	\$20,000	Leaking and repaired.
15	Barque Sarah Bridge.....	Portland....	Stroule.....	Gibraltar...	New Orleans	\$2,500	7,800	25,000	Tortugas. 500 tons salt.
17	Brig Josephine.....	Portsmouth.	Cushman...	Philadelphia	New Orleans	500	3,675	25,000	Near the light-ship. Carysfort.
20	Schr. Sonora.....	Baltimore...	Huffington..	San Blas....	Baltimore...	500	1,700	10,000	Struck the reef, and got off without assistance.
22	Brig Ganymede.....	Halifax.....	Toye.....	Falmouth...	New York..	3,558	5,000	15,000	Mattacumba. Bilged.
27	Ship Lord Seaton...	Belfast.....	Fitzsimmons	New Orleans	Liverpool...	9,000	21,700	110,000	Tortugas. 2,200 bales cotton. Condemned.
27	Schr. Charles Gager.	New York..	Miner.....	Jacksonville	Texas.....	.....	300	2,000	Leaking. Condemned. Cargo lumber.
Feb. 2	Brig Wanderer.....	Whitehaven.	Hodgson...	Jamaica.....	Liverpool...	600	1,840	6,000	Carysfort. Logwood and fustic.
7	Ship Abelino.....	Boston.....	Elliott.....	Boston.....	New Orleans	6,550	7,820	35,000	American shoals. Cargo ice.
25	Brig Isa. Reid.....	New York..	Rodgers....	New Orleans	Savannah...	3,000	4,500	17,000	Conch reef. Bored and sold by captain.
March 9	Barque Florida.....	New Orleans	Baron.....	New Orleans	S. Francisco	.....	500	15,000	Leaking and repaired.
11	Barque James Smith.	Hallowell...	Clarke.....	New Orleans	Philadelphia	8,200	12,600	30,000	Carysfort reef.
May 8	Brig Havana Packet.	Belgium....	Folkerts....	Havana.....	Antwerp....	1,800	3,300	30,000	Caser's creek. Bilged.
9	Schr. Sarah.....	Maine.....	Smith.....	New Orleans	Philadelphia	.....	1,000	6,000	Leaking and condemned and sold.
10	Schr. Leprelette.....	Maine.....	Bray.....	Attakapas..	Philadelphia	2,650	4,500	20,000	Tortugas.
July 8	Brig Wakulla.....	Camden....	Murray.....	New York..	St. Marks...	.....	1,500	10,000	Leaking.
Aug. 4	Schr. Emma.....	New Orleans	Page.....	New Orleans	Chagres....	.....	150	800	Leaking and condemned and sold.
16	Ship M. Howes.....	New York..	Patten.....	New York..	New Orleans	12,800	20,000	100,000	Near Sand Key.
16	Ship Emily Taylor...	Boston.....	Harding....	Boston.....	New Orleans	16,200	21,000	81,000	do do
22	Brig Morena.....	Cuba.....	Carera.....	Cuba.....	Barcelona...	2,080	4,475	15,000	do do Bilged.
27	Brig Sea Mew.....	New York..	Crawford...	Apalachicola	New York..	.....	3,500	23,000	Dismasted and cargo reshipped.

A statement of vessels wrecked on Florida reefs, and also of vessels having put into the port of Key West in distress, from the 1st of January the 31st December, 1850.—Continued.

Date.	Name of vessel.	Hailing from.	Capt's name.	Where from.	Bound for.	Amount of salvage.	Amount of salvage and expenses.	Value of vessel and cargo.	Remarks.
Sept. 25	Brig Chas. Kershaw.	Charleston..	Etchison....	Charleston..	Havana	900	1,800	6,000	Cape Florida.
Oct. 11	Schr. Athos	New York..	Godfrey	New York..	Matagorda..	.....	2,400	60,000	Leaking. Ashore on the Bahamas.
31	Barque Ranger	Portland...	Merrill	Massanilla..	New York..	4,000	9,000	18,000	Cæser's creek.
Nov. 13	Barque Gracialae	Trieste.....	Guan.....	New Orleans	Trieste.....	*14,343	17,400	50,000	do do Bilged.
Dec. 3	Barque Aquilla.....	Kennebunk.	Newell.....	Boston	New Orleans	2,400	3,100	20,000	Near Key West.
7	Barque Mara	New York..	Spall.....	St. Marks...	New York..	14,250	18,000	43,000	Tortugas.
14	Brig Damascus.....	New York..	Hayes.....	New Orleans	Genoa.....	*12,000	15,000	35,000	Ran ashore in a sinking condition.
22	Ship Niobe.....	Boston	Thomas	Boston	New Orleans	*5,000	5,000	†100,000	Tortugas. Got off by wreckers and proceeded.
24	Schr. A. Totten.....	Newport....	Jones	Boston	Apalachicola	.....	500	2,000	Leaking. Repaired.
	Total.....	.....	.....	.....	.....	122,831	200,860	929,800	

* Settled by arbitration.

† Reported value.

NOTE.—The British ship Erin go Bragh, Captain Thompson, six days ashore, got off without taking assistance—ship tight. Value of vessel and cargo \$111,000.

KEY WEST, December 31, 1850.

Your obedient servant,

JOHN C. HOYT, Agent for Underwriters.

APPENDIX O.

EXTRACTS FROM CONGRESSIONAL DOCUMENTS RELATING TO LIGHT-
HOUSES, &c., &c., &c.

Copy of a letter from Hon. W. J. Duane. [Senate document, No. 138,
2d session, 25th Congress.]

TREASURY DEPARTMENT U. S.,
Washington, September 16, 1833.

GENTLEMEN : I have received your letter of the 14th instant, and a copy of the twelfth edition of Blunt's Coast Pilot. If you will send to me the form of such a circular as you think likely to effect the useful purpose which you mention, I will give you all the assistance in my power. I am inclined to think the light-house system, as it is called, requires a thorough reform, both as to the style of lighting and the care of the keepers. I mean to omit no effort to place such an important and humane establishment upon a basis worthy of the country, and shall feel thankful to you for any assistance that it may be in your power to give to

Yours, very respectfully,

W. J. DUANE.

Messrs. E. & G. W. BLUNT.

Extract of a letter from E. & G. W. Blunt.

NEW YORK, September 18, 1833.

SIR : Your favor is at hand, and enclosed is the form of the circular, but which is applicable only to the Atlantic coasts ; as in the Gulf of Mexico there is no regular tide, nothing but a swell at the bars, though they had better be sent to all of the light keepers, as they may elicit some new facts.

There is, as you think, a great deficiency in our present light-house system, but it proceeds from a want of a proper degree of information in classifying the lights and in fixing the distinguishing character. The government is, in fact, too liberal in granting appropriations for them without due inquiry.

We refer you to the 115th No. of the Edinburgh Review for accurate information on light-houses, and our system is founded, as far as the lighting goes, on the English, without copying their best features ; for instance, the Tuskar, Eddystone, and Bell Rock lights are very important ones, and though far inferior to the Cordouan light, are much superior to any thing we have, as they have been fitted up at great expense, as coming under the first class of lights for importance. We have a coast not requiring very powerful lights, with the exception of Capes Hatteras, Fear, and Lookout, and the light near Carysfort and at the Tortugas ; and all our lights, even these, are of an inferior description.

The plan to improve the lights will be to classify them in the following order : The first class to be where the coast suddenly changes in direction, and has any dangerous shoal in its vicinity, such as the places above. This class to be lighted with the most improved lens, or on Lieutenant Drum-

mond's plan. These would have to be procured from Europe, and the light-houses would probably have to be enlarged.

2. The light-houses at the entrance of our seaports, which could be made better than they are even under the present system.

3. The light-houses merely meant as mile posts, such as some of the lights on Long Island sound.

No light-house should be erected or lighted without six months' previous notice. The character of any light-house should not be changed under one year's notice. The superintendent of the light-houses should give public notice of the bearings and distances from the principal points and shoals in the vicinity, and on which side (if it is near a port or inlet,) it stands. We have been at more trouble to ascertain about the light-houses than in any other species of information that we have ever undertaken. We will state a case out of many: Six months ago, when the Coast Pilot was in press, we applied to the collectors of Washington, N. C., Beaufort, Elizabeth City, and Newbern for information as to the lights in their respective districts. We paid the postages of the letters, and with the exception of the collector of Beaufort, we have received no replies, and the book therefore is deficient as to the North Carolina lights.

* * * * *

NEW YORK, October 7, 1837.

We, the undersigned, captains of packet and other ships trading between the port of New York and the ports in the English and Irish channels, at the request of Messrs. E. & G. W. Blunt for an opinion respecting the light-houses of Great Britain and those of the United States, state that the light-houses generally of Great Britain are, in our opinion, much superior to those of the United States. We would particularly instance the lights of Holyhead, Tuskar, Start Point, and Eddystone as *far superior* to those of Sandy Hook, the highlands of Navesink, Fire island, and Barnegat; these four latter important lights being at or near the entrance of the harbor of New York.

JOHN C. SMITH, *captain ship Pennsylvania.*

H. L. CHAMPLIN, *owner, and formerly master, in the London line.*

JAMES WATRON, *late of packet ship Virginia.*

JOHN LAKE, JR., *ship Herald.*

CHARLES E. BLUNT, *late of brig New Hampshire.*

JOHN C. HOYT, *ship Oberlin.*

L. W. MERRILL, *ship Coriolanus.*

SAMUEL KNAPP, *brig Alise.*

E. NYE, *packet ship Independence.*

C. N. MILES, *ship Harriet.*

A. HUTTLESTONE, *Ontario packet ship.*

JAMES FUNCK, *ship Baltimore, packet ship.*

WM. LE CRAW, *late ship Constitution, New York.*

J. DAYTON WILSON, *ship Oconee.*

J. D. SNOW, *ship Thames.*

L. WYEDERHOLDTZ, *ship Silvie de Grasse, packet.*

ROBERT GRISWOLD, *ship Toronto, packet.*

JOHN RATHBONE, *ship Oxford, packet.*

Communication from Messrs. E. & G. W. Blunt, of New York.

NEW YORK, November 30, 1837.

SIR: In a letter to R. Ela, Esq., an opinion was expressed by us, in general terms, that our light-house establishment was badly managed. An extract from our letter came to your notice, and, being sent to the Fifth Auditor, produced from him a denial of our statements, and called on us for proof of our assertions.

We feel no desire to hunt out official abuses or neglect; but our business is to give to the mariner information to guide him through his perilous course; to collate and compare the sailing directions and descriptions of coasts and harbors; to inform him if safe and continued reliance can be placed on the efficiency and good management of the lights and beacons of the coast described; and to receive from the intelligent mariner important information to impart to others.

In the course of our inquiries, our attention has been very often called to the situation and management of the many lights provided by our own government. The amount expended in the erection of light-houses, and the sums annually appropriated for their maintenance, are sufficient, if distributed by a judicious, industrious, and energetic head, to produce all the results claimed in the note of the Fifth Auditor. That these results are not effected, is the object of this paper to prove.

We are satisfied that, on comparison of our light-houses and their management with the similar establishments of France and Great Britain, ours are greatly inferior. We have formed this opinion from a careful examination of the opinions expressed by shipmasters, who are constantly comparing the lights; and they, of all others, are the best judges. Pilots and steamboat captains, who are confined to our own coasts, are, for the most part, incapable of giving correct opinions; for they see none but our poor lights, and seldom, if ever, see the lights of Europe.

The captains of the fine lines of packets from this port to the ports of England and France have a better opportunity of comparing lights than any others. They all concur in the opinion that ours are greatly inferior in brilliancy, in the distance they may be seen, and in good management. They have made the inferiority of our lights a subject of complaint for a long while. We have requested a number of them to state their opinions in writing. The papers marked A and B bear the signatures of some of the most intelligent of our shipmasters. No pains were taken to procure signatures, the papers never having been sent from our store.

Two new light-houses have recently been erected at Abaco and Gun Cay, by the British government. They are represented as being very superior lights; and their proximity to our own coasts affords a good opportunity of comparison. We have no two lights equal to them. We send in paper B some evidence as to the character of these lights, and also a chart of that part of the Bahama bank on which they are placed. Every shipmaster with whom we have conversed, who has seen these lights, speaks in admiration of their power, and the distance they may be seen. They afford a good example of modern British lights. Circumstances relative to their erection, in some measure, indicate their superiority, and the inferiority of our own lights. The lantern and apparatus for lighting were sent from England; the buildings were contracted for in Boston, whether by the individual from that city who has built so many light-houses on our

own coasts, we are not informed; but it appears this American mode of building light-houses did not meet the approval of the officer of engineers appointed to superintend them. The contractors broke off, and other parties from Nassau completed them. (See paper D.)

The French light-houses are even superior to the English. Instead of the parabolic reflectors, they use the lens. We beg to refer you to the testimony of Lieutenant Thomas Drummond, given in "Minutes of evidence taken before the Select Committee on Light-houses, with their report, ordered to be printed by the House of Commons in 1834, and reference to Sir David Brewster's improvements," &c. We have been for years behind other nations in taking advantage of improvements; but if we were to judge from an advertisement for a contract of the "patent lamps," we should suppose something new was in contemplation. It is nothing but the Argand lamp, with miserable arrangements.

It will be seen, on reference to the remarks on Gun Cay and Abaco light-houses, that an officer of engineers was appointed to superintend the erection of those two light-houses. No such supervision is thought necessary in the erection of our light-houses, and the consequences are evident, in badly constructed buildings. Mr. Winslow Lewis, of Boston, contracted for the building of two light-houses at St. Augustine and Mosquito inlet, on the coast of Florida. The contract, as Mr. Rodman, the collector, informs us, was vague and defective, and the work very slightly done; and the consequence was, that both fell to the ground. We refer you to a copy of a letter from Mr. Rodman to us, marked C. Yet the system which produces such structures is called the best in the world; and the deceived superintendent congratulates himself on its good management.

A dwelling-house connected with the light-house is now being erected at Montauk point. It is by contract. The cellar walls are not laid in mortar, and improper sized stone filled in next the earth. The material, generally, is bad for a work of that kind. This is the opinion of Colonel Livingston, who visited it with Mr. E. Blunt; and the contractor differs in opinion from those who have seen the work, as to the measuring of "the height of the brickwork from the floor;" but it is said to be according to contract, and they were *not* to use the *best* materials. A new well has been dug, and is said not to be sufficiently deep, by the residents; the old one has been filled up by the contractor, contrary to the wish of the keeper. Now who is to blame? Certainly not the *Collector of Sag Harbor*: he resides many miles distant, and there is no provision for him to go there to attend to the details. It is the system.

Under the collectorship of the late John P. Decatur, a light-house was erected at Whale's Back near the entrance of Portsmouth harbor; it was built by contract, of stone. No proper supervision was held over the contractors; it was very badly built, and has recently been *boarded* and *shingled*; as they say in Portsmouth, made into a wooden one, (see paper E.)

In almost every instance where we have seen repairs, they have been unfaithfully done; and, on landing at Gull island, one is surprised to see the walls constructed in a faithful manner, after having seen other works.

As far as our knowledge extends, concerning the general management of lamps, &c., there are but few in our own neighborhood which are in good condition, among which are Prince's bay, Plumb island, and Old Field. The lamps in most of the others are bad and leaky. Take Montauk as an instance: the reflectors are of various figures; there is, in all, no proper

way of ventilating the lamp room, and the moisture, mixed with soot from the top of the lantern, freezes on the glass in cold weather.

The light-house, lamps, &c., at Eaton's neck, have been reported, to our own knowledge, for eight years: concerning this light, a highly intelligent officer, Lieutenant Blake, now employed in the coast survey, informs us that, having heard many and frequent complaints of this light, he went into the lantern for the purpose of examining it. He there found the lamps very defective, made many years since, and of bad construction; the keeper admitted that the lights were bad, and that he was censured for keeping a bad light; that he had represented the matter to Mr. Pleasonton, and no remedy had been applied. Lieutenant Blake having been employed so long in surveying Long Island sound, and convinced of the exceeding importance of a good light in this particular location, called on the Fifth Auditor, at Washington, and stated, in detail, the imperfections of this light. Mr. Pleasonton informed him he was greatly astonished at this information, and would take immediate steps to redress the evils complained of. Mr. Pleasonton, at the same time, showed Lieutenant Blake a very fine made lamp and reflector, and informed him that they were a sample of the kind contracted for. Notwithstanding all this, and the knowledge of this light being so defective *was so clearly brought to the notice of the superintendent*, the light still remains unaltered, and Lieutenant Blake, in visiting it the last summer, a year after his notice, found every thing as formerly. Most if not all the lamps of this house should have been condemned many years since; the light, for the most part, cannot be seen more than seven or eight miles.

The light at the Tortugas should, from its position, be a light of the first class; it has long been noticed by mariners as a very bad one; and we felt justified, in our last edition of the American Coast Pilot, in remarking on the very bad manner in which this light is kept. Lieutenant Gedney, of the United States navy, who has been much employed by government about the Florida reef, gave notice to Mr. Pleasonton that the management of this light needed reforming; it still remains a very bad light.

The light at Watch Hill is a very bad one; the lamps are bad, the reflectors too small and of bad figure, and some of them cannot be adjusted. It is a singular instance of ignorance that before each light there is placed a thick piece of glass, the usual ship deck light for a lens. The effect of this is in a great measure to destroy the effect of the lamps.

A few days since, our Mr. Edmund Blunt, engaged in the coast survey service, near this light, noticed that the opposite sides did not show alike, as the machine performed its revolutions, and he requested the keeper to remove for a short time the "lenses," to enable him to see if it was owing to the reflectors. The effect was astonishing; the brilliancy was increased very much, particularly on one side.

One side was increased but little, owing to the light on this side being lost for want of reflectors. When this experiment was tried, the surveyor of the port, Colonel Brown, was present, and remarked that the light increased so much in brilliancy that they would not know what to make of it at Stonington. The machinery of this light is so bad that the revolutions are not regular, and it sometimes requires being turned by hand. This light formerly burned ten lamps, two of the lamps having two burners each, but owing to some mistake in the contract, they now burn but eight lights.

The superintendent would not direct the keeper to extinguish two lights,

but ordered him "to cause the two double lamps to be so lighted as that no more oil shall be consumed in them than is consumed in any other two of your single lamps." The keeper being unable to comprehend these directions, was compelled to extinguish two lights.

It is believed many other revolving lights on our coast have this combination of the reflector and a thick piece of glass similar to ship's deck lights; in a similar instance, the North Foreland light.

In the language of Lieutenant Drummond, "the result of this arrangement was entirely to destroy the effect of the reflectors, and in fact it was absolutely putting a shade before a very good light. In ordinary cases, a window of the lantern is of thick clear plate glass; but here, instead of the plate glass, they put a lens in front of each, which destroyed the parallelism of the beam of light from the reflector, and entirely injured its effect." On the North Foreland light coming into possession of the Trinity House in 1831, these glasses were immediately removed. The light was consequently rendered much more brilliant. In this case an original expense of £750 was incurred to destroy a good light. There is no room for doubt that the glasses used in our light-houses, and which we understand are similar though much inferior to those described as formerly used in the North Foreland light, are all injurious to the efficiency of the light; from their construction, they cannot be otherwise. We believe they have been furnished by contracts with Mr. W. Lewis, for the most part, and are patented. It would be well worth the inquiry to ascertain the whole cost to the public of this ingenious patent to obscure lights.

We understand that formal, and, as we believe, well grounded complaints were made by the superintendent of the light at White island, against the keeper, for neglect of duty in not taking proper care of his light, and being long absent from his light-house without permission; leaving it, during his absence, under charge of a female. The complaint was made to the proper authority at Washington. On these complaints, and on other accounts connected with the keeper and known to the inhabitants of Portsmouth, a removal from office would have been just, and would have afforded an example to others.

We have, in another place, remarked that there is no examination of the quality of the oil furnished for our light-houses, and intimated that the quality is not generally such as required by the contracts. For winter's use, we believe, pure winter strained oil is contracted for. The heat in the light-room of a light-house is very considerable from the lamps, and the oil must be of very poor quality to congeal. We are informed that the collector at Portsmouth, last winter, despatched a vessel with charcoal to the light-houses at Boon island and White island, to use in the light-rooms, to prevent the oil from being congealed. The accounts in the bureau of the superintendent of lights will furnish some evidence on this point. It is easy to determine the purity of oil, and every cask should be submitted "to a most particular species of trial." While the contractors have the ordering of this matter, every cask will be of the first quality *in their reports*.

It is, indeed, absurd to believe that a mere bureau at Washington can oversee and manage, in a proper manner, the details of a system of light-houses, beacons, and buoys, for the coasts of the United States. At the commencement of our present system, when the lights were few in number, an energetic man might possibly have secured, by great industry, the proper

management of our lights. For many years the superintendent has been, in fact, but the head to receive reports from contractors, and the agent to pay salaries, &c.; his office is, besides, charged with other duties.

The duty of inspection of light-houses built by contract, of overseeing keepers in the execution of their duties, is left to the collectors of districts; these are generally sufficiently engaged in the collection of the revenue, and rarely visit the lights. Nothing of that close and exact supervision, such as is practised in England, is had in this country. The collectors rarely visit the lights. How often, for instance, does the collector of Portsmouth visit Boon island? Not twice in five years! And the same may probably be remarked of Nantucket great point light, Montauk point, and many others. We doubt much if the Mount Desert light has ever been visited by a collector.

The Secretary of the Treasury is very properly placed at the head of the light-house department, but, until the duty of frequent examination and inspection is enforced, our light-houses will remain a reproach to this great country, feebly and inefficiently managed, and at the mercy of contractors.

This examination should be extended to the system in all its parts, from the construction of a light-house, to the lamps, reflectors, and keepers. Officers in the navy; in many cases, perhaps, in the great cities, committees from chambers of commerce; and individuals disconnected entirely from contracts for supplies, would furnish the material, and frequent and rigid examinations would soon produce a thorough reform.

There are now building sixty or seventy new light-houses. When built, and within a week or so of being lighted, the collectors, if ordinarily diligent, will give public information in the district paper in which the light-house is erected. The information will be gradually diffused; vessels from Europe, the East Indies, and elsewhere, will, on their return, learn that some important light-houses have been erected; they may, in many cases, first discover them on their approach to our coasts, and pay dear for the discovery by shipwreck, as in the case of the *Galaxy*.

The frequency of alterations in light-houses, the extinguishing the lights in consequence, and even, in one instance, for want of oil, have been greatly complained of. In the well regulated public lights of France and Great Britain, alterations are never made without long previous notice. We proceed to notice a few instances of such alterations; premising that, in all cases, we endeavor to become acquainted with their alterations, and give extensive notice accordingly. We have, however, found this oftentimes extremely difficult.

Daniel P. Brown, the collector at Portsmouth, gave notice, not exceeding, we believe, five days previous, that the light on White island, one of the group of the Isle of Shoals, would be extinguished; it was accordingly extinguished for about five days. This is a very important light for vessels bound to Portsmouth from Europe and the West Indies; they often run for and make this light. Previous to the erection of this light, many deplorable shipwrecks took place on the rocks and shoals surrounding this dangerous group. Twenty years since a large Spanish ship was lost, with every soul on board, within one mile of the islet on which is the present light.

The ship *Galaxy*, Captain Goodrich, on her passage from Canton to New York, with a very valuable cargo, was lost near the entrance of this harbor. The light-house at Barnegat was erected and lighted during his absence;

the captain made the light, and asserted, on his arrival, that he lost his vessel in consequence of his ignorance of the existence of a light there ; having shaped his course believing it another and a well known light. The first notice we had that the light was lighted, was from a person who saw it in passing. We wrote to Governor Woodbury, then Secretary of the Treasury, to know why public notice had not been given of the same ; who, with his usual promptitude, caused the inquiry to be made. We then ascertained that the collector of the district had advertised it in a paper published at *Egg Harbor*. This light is of sufficient importance to have it considered a light of the first class, and not a mere local one. It is of more consequence to vessels bound to New York than to any others, and notice might almost as well have been put on the door of the building, as in an obscure country paper. The Messrs. Griswold, by the shipwreck of the *Galaxy*, suffered a loss of \$50,000, and the revenue a large sum. An intelligent and active superintendent of lights would have caused the most ample previous notice to have been given by our consul at Canton, and the consuls and commercial agents in all foreign ports ; and this is the practice adopted, we believe, by the consuls of other countries with us, in similar cases.

We have frequently urged on the superintendent the importance of giving ample notice of the erection and alteration of lights. Our last letter to him, of March 21st, 1833, on this important point, has never been acknowledged. In that letter we urged the importance to the mariner and merchant of the earliest possible notice being given.

The light at Mobile point is a very important one. We will hereafter make some remarks as to the necessity of altering the character of this light at all.

We believe the alteration of Mobile light was made without any previous notice ; we have been unable to find any, and Mr. Pleasonton is silent, having confined his remarks to the general necessity, as he thinks, of the alteration. We recollect well this sudden change was a subject of indignant comment among shipmasters. The ship *Cahawba*, Captain Smith, then a regular trader between New York and Mobile, on her return to Mobile, in forty days from the time she had left that place, found the light revolving, which he had left fixed. He had heard of no alteration being contemplated, and consequently ran by it, and came near being lost. He made the next light west of it, and discovered his mistake, and was four or five days working back. Captain Lake asserts, and so does Captain Hamilton, that they were lying at Mobile bay, when the alteration was made, and had no knowledge any change was intended. Captain Boune, of the *Columbus*, who was also lying at Mobile, concurs with Captains Lake and Hamilton. We beg leave to refer you to the statements of Captains Lake and Bailey, and to those of Captains Josiah C. Kelly and Nehemiah D. Kelly. See also the paper I, signed by an old and highly respected shipmaster, Captain Snow, of ship *Thames*.

It is asserted that the alteration of this light was a judicious one. It seems the alteration was made in consequence of certain reasons furnished by Mr. Winslow Lewis. We are not furnished with these reasons. Some previous complaints being made, it seems Mr. Pleasonton has obtained from "pilots" and "steamboat captains" opinions corroborating those of Mr. Winslow Lewis. In the absence of proof, to be obtained (if possible) from intelligent shipmasters navigating from Europe or the northern ports

to Mobile, the opinions of pilots and shipmasters are not of sufficient authority. We send with this a chart for your inspection, and we think on examining it you will agree with us, that the alteration ought not to have been made at all. Whilst it was a *fixed* light, it could not be mistaken for Pensacola light, which was and is revolving. The light-houses at Cape St. George, and at the passes of the Mississippi, are too far distant to be mistaken. Was it to distinguish it from the light at Cat island, or that at Horn island—two lights only intended to guide small craft and steamboats through the entrances into Dauphin Island sound and Lake Borgne? The old and experienced shipmasters, trading to Mobile, assert the alteration was unnecessary, and, being made without notice, wantonly careless and reprehensible. Mr. Pleasonton seems to doubt the propriety of this alteration himself, for another light-house, he informs us, is in course of erection at Mobile; for what particular service we are unable to say, but suppose to distinguish it from Pensacola light.

Mr. Pleasonton states that the distance between Pensacola light and Mobile is so great, that there is no danger of confounding the two lights; the distance is but forty miles. A few days bad weather, and an error of forty miles is by no means an improbable one. We have just received an account of a vessel and all hands being lost, by mistaking the two lights at Cape Ann for the two at Newburyport.

The important light at Cape Hatteras, not long since requiring repairs, was extinguished at very short notice; and an advertisement appeared that a light at Florida would be extinguished *for want of oil*. Some memoranda respecting the lights at Block island, and at Prospect, Maine, will be found on paper marked G.

In Mr. Pleasonton's letter to Governor Woodbury, he asserts that the complaint respecting the light-ship on Five-fathom bank, off the Delaware, *is entitled to no notice*; she being always placed by some competent person.

This light-ship was placed in her first position by our Mr. George W. Blunt, under the direction of the collector of New York. Mr. Blunt proceeded to the spot, determined her position by accurate bearings, and on his return caused the publication in our papers of her precise position. We request you to examine the chart accompanying this, in which her first position is denoted by the engraved figure, and her late position by the figure in ink; such a remarkable alteration deserves especial notice, and to a vessel leaving the capes in the fall and returning in the spring, would be highly dangerous. Pilots are sometimes taken from this ship in the night: supposing a ship in the place on the chart marked X, unacquainted with the alteration, should make the light at nightfall, and run for her, to procure a pilot; she would probably give the light a birth of a mile or two to keep well clear of her. She would, in that case, strike the bank, there being but from two to three fathoms. The ship James Cropper and cargo, homeward bound from Europe, were totally lost on this bank. By what "competent person" the alteration was made, we are not informed. There was but very short notice of the change of place. As soon as we were informed of it, we caused the chart to be altered, and gave notice in our books of directions accordingly. It probably will be learned that the competent person was the light-keeper, whose new position afforded him better shelter from the sea.

We infer, from Mr. Pleasonton's letter, that the restoration of this vessel

to her old place was made at his instance; and, by his direction, she is, without doubt, now placed where she should be. But the restoration was made by the instrumentality of the chamber of commerce of Philadelphia, who conceived the subject worthy of their interference, as indeed it was. John Vaughn, esq., a committee of the chamber of commerce, wrote us on the subject. (A copy of his letter is marked F.) We have accordingly placed her in her old place, or nearly so, on the chart, and given notice of the change by all the means in our power; but the home-bound mariner will again be perplexed by the change.

On Mr. Duane's coming into office, his attention was directed to the management of our light-houses. It will be perceived he was aware of the imperfections of our system, as appears by a correspondence with him in 1833, copies of which we annex to this paper. Our views, as then given in our reply, have experienced considerable change; the more recent great improvements in English and French lights rendering the contrast, at this time, still greater than then.

The mode of providing oil for our light-houses is by contract; and this, doubtless, is the best manner to provide for the public service generally, wherever practicable, but requires a constant and rigid supervision and examination. *Every cask* of oil, furnished for the lights of Great Britain, is forwarded to public stores at London, Dublin, or Edinburgh, and from thence distributed, "*after having separately undergone a most particular species of trial.*" There is, we believe no examination in this country. The oil is generally contracted for at New Bedford, and from thence sent directly to the light-houses. For the good quality of the oil, the superintendent depends on the representation of the keeper; and for good management and proper care of the lights, on the representations of the oil contractors. Here is a novel system of checks; and, as may well be believed, the oil is frequently bad. The keeper of Black Rock harbor light informed Lieutenant Blake that, in the winter, his oil became congealed, and he was obliged to *shovel* it out of the cask, and render it fluid at his dwelling-house, before he could fill his lamps.

Little or no attention is paid to the police of the establishment. In the British public light-houses, a light-keeper is required to be in constant attendance during the night, in or near the light-room; he is required to keep a journal; note the times of lighting and extinguishing; the weather, &c. Their lights are frequently visited and examined; and the numerous armed vessels, and the coast guard service, exercise a constant supervision, and reports are statedly made. The number of lights in the United Kingdom is 219, about the same number that are erected on our coasts, and their preservation and effective management is guarded with jealous care by several public bodies. Yet it is pretended that our establishment is managed in a better manner throughout than that of Great Britain. There is something painful in this delusion. When the lives of our mariners, and vast amounts of property, may depend on the good management of our lights, little reliance should be placed on the representations of oil contractors or light-keepers: in place of this, there should be an exact and uncompromising supervision.

There is little intercourse between the light-keepers and the Fifth Auditor, except through contractors. We frequently have complaints made to us of the lights going out, or not being properly attended to. It is not our business to correct the evils complained of; we can only lament that

the liberal appropriations of Congress should not have, in a complete manner, the beneficent effect intended.

The machinery of every light-house which we have visited, for producing the revolutions, is of very bad construction. A report on this subject was made by our Mr. E. Blunt, several years since, concerning the light at Fire island, which will be found in the office of the Fifth Auditor.

The material of the lanterns is bad: the frames may be of iron, but the outer part should be of bronze, well soldered on, and no iron in contact with copper, on the outer or exposed part; and the glass should be *plate* glass.

We venture to assert that, if an accurate description of the lights on our coast were now required, and the particular purpose for which each was erected, it could not be furnished: all this should be in the office of the Fifth Auditor. The collector of Boston, when requested by Mr. Pleasonton to forward a description of the lights of his district, made an extract, and says it is from Blunt's American Coast Pilot, doubtless the best authority; but it seems strange that a *description* of light-houses should be *wanting* at the Fifth Auditor's office, when the establishment has been under his charge for over twenty years.

We have not, however, believed the Fifth Auditor's office to be the best source to look for accurate information, for a long period. We received, from the hydrographer of the admiralty, a request to forward to him a description of our lights, their latitudes and longitudes, magnetic bearings and distances, &c., &c.; in short, the information sought for in the paper sent us, marked W. Other great maritime nations take a strong interest in these establishments.

The keepers of our light-houses should be furnished with the time for lighting and extinguishing their lights for every day of the year; the lamps should be examined as often as every four hours, and, in very cold weather, oftener. For lights of the first class, one keeper is insufficient; if the keeper is infirm, he should have two assistants. The practice of leaving the lights for a longer period than twelve hours, is forbidden, without permission of the collector; yet it is common, and instances can be pointed out, of the absence of light-house keepers from their lights for many consecutive weeks.

There has been published at Washington, by Robert Mills, a small work, called the American Pharos, claiming to describe accurately the lights of the American coast. This work contains many pages of sailing directions, &c., extracted from the American Coast Pilot, being in some cases extracted by collectors, to whom certain queries were forwarded by the superintendents, and in others pirated by the compiler from the Coast Pilot.

The American Pharos contains many dangerous errors, and is altogether a work on which no dependence should be placed.

The remarks are made on this work from the fact that the superintendent of lights furnished from his office a large portion of the information given in it, and has in a measure given it the sanction of government authority; and a new edition under Mr. Pleasonton's patronage is promised. We trust this new edition will be carefully examined, and the numerous errors of the first corrected.

At the session of Congress of _____, large appropriations were made for new light-houses; a clause was appended to the bill, directing a previous examination to be made, by certain naval officers, and providing

no light-house should be erected, unless, on proper inquiry, they deemed it essential for the commercial interests of the country. We trust this commission will form a new era in our light-house establishment, and that it will extend, also, to the location, construction, and management of our lights.

Naval officers of a certain rank are, from their position, well fitted as supervisors of our lights. They know the immense value set on good lights by seamen; their feelings are in favor of this class, and they are far removed from any suspicion of influence from any quarter. A board composed of three naval captains, clothed with proper powers, would insure the good management of our lights, and promptly report all delinquencies, if any should occur.

The naval captains selected, under the act of Congress above mentioned, were Captains Kearney, Sloat, and Perry, to examine the sites of the light-houses intended to be erected in and near this harbor. The selection was a judicious one; they addressed circulars to many individuals, and personally examined the sites, and have indicated in their report the proper positions of the new lights.

The attention of Captain Matthew C. Perry, of this board, was called to the situation of our present light-houses, and he has entered into an elaborate examination of them, their mode of lighting, management, and the comparative expense attending them, with those of other nations. We believe he agrees with us in the opinion expressed in this paper, that our light-house establishment is quite inferior to that of France or Great Britain; *that the expense is greater*; and that, in short, in point of economy, their lights cost less, as well as being far more effective. Without, however, intending to enter into an exposition of what we understand to be his views, we refer you to two papers recently forwarded by captain Perry to the Navy Department. He has entered into a more careful examination of the expense of our system and foreign ones; and, from his character and position, his opinions will, as they ought, have great weight. We therefore respectfully request that the papers communicated by him to the Navy Department may be examined by you.

One of the new light-houses in this harbor is to be placed on "Flynn's knoll." Flynn's knoll is a sand bank under water, and when this light is completed it will, with the light on Sandy Hook, indicate the boundaries of the main or ship channel. The practice of building light-houses by contract, in the usual manner, is, in this case, very properly changed; it is placed under the superintendence of Major Smith of the corps of engineers. It will be an exceedingly important light, and will afford an excellent opportunity of trying the lens used in all the light-houses of France, and which are doubtless superior to the parabolic reflectors used in England, and *at much less expense*. The whole apparatus should be imported from France. The manufacture of these lenses is a government concern, and they are not made for sale, but have been furnished by the French government, in several instances, to other nations. It would be necessary to state the kind of light required, the dimensions of the building, &c. Our Mr. Edmund Blunt, when last in Europe, inspected the establishment for the manufacture of lenses. He was furnished with an introduction to Monsieur Fresnel, the superintendent, from the *Depôt de la Marine*. Monsieur Fresnel entered fully into every explanation required, and exhibited drawings illustrative of the works. Some glasses resembling *ship's deck lights*

have been introduced into some of our light-houses, and we believe called lenses, but, manufactured in ignorance of scientific principles, and of bad metal, have proved worthless.

In locating a light-house, arranging the lamp, and in the appointment of keeper, those living in the immediate neighborhood are too often allowed to have too much influence, save for the lights erected merely for local purposes. Pilots or steamboat captains should not be consulted.

In the appointment of light keepers, it is often necessary that other qualifications besides the capacity to keep a light in good order should be considered, when the light-houses are in situations remote from settlements. It frequently happens that the keepers can render assistance to those who are shipwrecked, or to vessels in distress. This was taken into consideration when the merchants of New York recommended Mr. Smith as keeper of Fire island light. He had been instrumental in saving many lives, and distinguished himself in rescuing the few survivors from the wreck of the Mexico, last winter.

Many of the keepers require a proper boat. We have known cases where a vessel in distress, and very near the shore, was obliged to put to sea again, the keeper of the light being unable to board for want of a boat.

Should it ever be thought proper by the Secretary of the Treasury to carry into effect such a close and frequent examination of our light-houses, by a board of naval captains, or others, as suggested in a former part of this paper, we think the commission should include a scientific individual, well acquainted with optical principles applicable to light-houses. Some proper examination has become indispensable.

It is now half a century since Edmund M. Blunt, esq., commenced the American Coast Pilot—a work professing, as far as possible, to give accurate descriptions of the coasts and harbors of the United States, and directions for approaching and departing from the same; and the rocks and shoals, and the buoys, beacons, and light-houses erected to guide the mariner in his perilous course. It becomes not us, his successors, and the publishers of the later editions of this work, to claim for him, or ourselves, other merit than that of an earnest desire to serve the interests of commerce, and render the dangerous course of the mariner more secure; but, as evidence of the value of this work by those for whose benefit it was commenced, and has been continued, there have been published thirteen editions averaging four thousand copies each, the later editions being extended to seven hundred pages. For this work, we have, in several instances, asked from the government information respecting surveys, light-houses, &c., to become the medium to disseminate the same to seamen. Our applications, in some instances, have been refused, in others, unanswered. We have in vain attempted to procure from Washington information respecting light-houses. Several years since, we forwarded to Mr. Pleasonton a few letters addressed to keepers of light-houses, as we knew not how to direct accurately, by mail, and requested his assistance. We received from him such a reply as precluded any further similar request.

It is unnecessary here to speak of the general ability and intelligence of our shipmasters, and of the vast amount of property committed to their charge. We owe it to this class of our fellow-citizens, with whom we are so closely connected, to do all in our power to bring to your knowledge the abuses that have crept into the important establishment created for their

benefit and the interests of commerce, confident that you will apply the proper remedy.

The establishment has increased beyond the ability of any single individual at Washington to superintend it in its more important details; and the efficiency of the whole has become greatly lessened. The intelligent gentleman who, for so many years, has had the general superintendence of the lights, has had but little assistance of the proper kind; he has been compelled to rely too much on contractors, and the representations of contractors will always be favorable. The duties of the office of superintendent of lights, at Washington, coming immediately under the direction of the present incumbent, have been conducted, to the best of our knowledge, with skill and promptitude; but these duties have been, for many years, almost necessarily confined to the payment of salaries and contractors, and other financial matters; and there can be no doubt this least important part of the whole system has been exceedingly well managed. If, in some cases, abuses, when brought to his notice, have not been promptly corrected, his situation may not have furnished him with the necessary means; but the attention of the superintendent has oftentimes been called to the immense importance of giving long previous notices of the intended alterations, and the establishment of new lights. For the most part, this information can be easily given, and cannot be neglected without great risk of human life and the loss of property; and the great number of new light-houses now in progress renders this duty still more imperative. It remains for him to show that this duty has always been performed, or to give reason for the omission.

We have the honor to be, very respectfully, your obedient servants,
E. & G. W. BLUNT.

To Hon. LEVI WOODBURY,
Secretary of the Treasury.

Extract from a communication of E. & G. W. Blunt, (Doc. 138.)

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It will be seen, therefore, at an annual expense of £405 per light-house, the coast of Scotland is provided with lights, a numerous corps of keepers and boatmen, *kept in repair* and lighted, furnished with fuel, &c. &c. If, from the estimate of expenses, we should deduct the cost of the extra boatmen and assistant light-keepers, and incidental expenses, over and above what are furnished to our establishment, the cost would be far less than ours. Other considerations, of a much higher nature, however—the loss of life and property by a bad light—should enter into view. The loss in duties to government, or the ruin of merchants by shipwreck, should urge as liberal expenditures; and every thing necessary should be provided for, to make our light-house establishment the best in the world. If, then, they can be managed with “less than one-half of the expense,” than the similar establishments of other countries, the gentleman who may have our system under his superintendence may congratulate himself with reason.

It is easier to compare the expenditure connected with the light-house service of *France*, the light-houses for the whole coast being lighted and maintained by contract. The contract includes,

1. Supplies of oil, wicks, tubes, and other articles required for lighting and keeping the apparatus in order.

2. Repairs of lamps, plate glass, annual painting, repairs of lodging rooms, &c.

3. Wages of the keepers and their fuel, and a salary paid in each department to the agent of the contractor.

The amount paid for the above for twenty-one light-houses and forty-eight harbor lights, sixty-nine in all, is 176,013 francs, or say, in round numbers in dollars, per light, \$480.

Mons. Fresnel, the principal engineer of the light-house commission of France, says, "that the expense of lighting the light-houses of England must be one and a half or twice as great as that of France, all things else being equal. Supposing it a mean of one and three-quarters, we shall approximate nearly to the cost of the *English* lights, which will then be \$840 per light; a sum, we believe, less than the cost of lighting and maintaining the lights of the United States." In this estimate he doubtless deducts all those numerous items of expenditure, chargeable on the English, such as pensions, charities, &c., &c., and numerous expensive contingencies, which are not chargeable on the French lights, and which, also, do not come into view in comparison with our own lights.

Extract from a letter of E. & G. W. Blunt to the Secretary of the Treasury, February 22, 1838. [Senate Document No. 258, 2d session, 25th Congress.]

We indeed believe that every essential object would be attained by placing the *details* of the building and management of our light-houses in the Engineer's Department, subject to the control of the Secretary of the Treasury; and that a certain inspection and report, by naval captains, would be all that is necessary.

Whatever disposition may be made of this inquiry; whether the system, as it is now administered, will be suffered to go on; or whether such a supervision as the interests of commerce and the lives of seamen require, will be for the future obtained, we have discharged our duty in calling the subject to your attention.

Although we have for a long time been aware that our light-house establishment was badly managed, and that, in comparing ours with those of Great Britain and France, the time could not be much longer delayed, when the whole subject would be forced on your notice, and the proper remedy applied, yet we expected no opposition on the part of the superintendent of lights; we believed that it was but necessary to show him we were behind other nations, for himself to commence an improvement. Instead of this, we find him making common cause with a contractor, and claiming, in the face of all evidence, that his establishment needs no improvement, and that he has kept the whole in a condition of which he feels proud. He bases the whole defence of his administration on the statement of an individual, vitally interested in the continuance of the present state of things, and on statements impossible to be correct.

We have no pecuniary interest in this discussion; we are neither contractors nor expectants. As publishers of nautical works, and nearly con-

nected with nautical men, we feel an interest in everything that belongs to their profession. Congress has liberally made every appropriation asked for, and no pains nor expense should be spared to make our light-houses as perfect as possible; for on the certainty of seeing them at sufficient distances, often depends many valuable lives and great property. The mere question of saving money in the building and management of light-houses, seems to be mistaken for economy. The value of one ship and cargo, for instance, the ship *America*, lost on the *Tortugas*, was greater than the annual cost of the maintenance of all our light-houses and light-ships.

If, in this important inquiry, we have proved, as we believe we must have done, that the assertion we first made, that our light-house establishment, the general superintendence of it, and its whole management, is inferior to the establishments of Great Britain and France, and needs a thorough reform, we believe that we shall already have been instrumental in commencing a new and more complete arrangement.

We think that the statements first made by us are fully borne out by the evidence brought forward; and that the whole system needs revision, a strict superintendence and a different plan of operations, none will, we believe, deny. What that plan ought to be, is for the wisdom of Congress to decide.

E. & G. W. BLUNT.

FEBRUARY, 1838.

The undersigned, ship masters from the port of New York, hereby certify that they are familiar with the lights upon Sandy Hook and highlands of Navesink, and that in their opinion the one upon Sandy Hook cannot be seen in clear weather further than from twelve to fifteen miles distance, and the one upon the highlands of Navesink from eighteen to twenty miles. And they would further state that the largest English lights, say Cape Clear, Tuskar, Holyhead, &c., can be seen at a distance of from thirty-five to forty miles.

CHARLES H. MARSHALL, *Agent for old line Liverpool packets.*

HENRY HOLDREDGE, *packet ship Washington.*

N. H. HOLDREDGE, *packet United States.*

JOSEPH TINKAM.

BENJ. L. WAITE, *ship England.*

WILLIAM G. BARSTOW, *ship South America.*

JOHN P. SMITH, *ship Pennsylvania.*

NEW YORK, February 12, 1848.

The undersigned, captains of vessels engaged in the trade between the United States and the ports of Great Britain and France, being requested to state our opinions of the quality of the lights on the coasts of the United States, and those on the coasts of Great Britain and France, certify and say: that the lights of the latter are altogether superior to those of the United States, and that in our frequent voyages we have an opportunity of direct comparison. We state further, that, in our opinion, there is a necessity of great improvement in our light-houses, and that the lives of mariners, and our great increasing commerce, require the attention of government to this important subject.

We do not certify so much to the size of the lights, as to their brilliancy; in this particular, the English and French lights are immeasurably superior.

E. CRABTREE.

JAS. L. WILSON.

CHARLES MANSFIELD, *ship Robert Bowne*.

DANIEL CHADWICK, *ship Wellington, London packet*.

OLIVER R. MUMFORD, *ship Hannibal*.

SMITH PLACE, *steam-packet Neptune*.

W. SINCLAIR, *bark Virginia*.

W. G. HACKSTAFF, *ship Scotland*.

GEO. F. MUSTARD, *ship Majestic*.

WM. DOLLON, *bark Paoli*.

N. S. MAURAN, *ship Montezuma*.

Extract from a letter from Joseph Grinnell, Esq., of New Bedford, of February 14, 1838.*

Yours, relative to the comparative merits of the English and French light-houses with our own, was duly received. I have no hesitation in saying that the English are superior to ours, owing to the form of the reflectors; and that the French are superior to the English, in consequence of the construction of the lamps with concentric burners or sockets, and the use of lenses. When in England, I visited the Trinity House, and acquired all the information I could of their lamps, &c.; procured one of their reflectors and sent home, which I presume is here. I was informed by the gentlemen who superintended the English light-houses, that commissioners had visited France to examine their lights, and returned convinced that they were far superior; that they had erected one, and were about to erect others, on the French system. At Havre, I visited the lights; found them on the same plan as the English; the new lamps and lenses had only been put in use at Bordeaux, and a few other important points. At Paris I fortunately made the acquaintance of Mr. Fresnel, son† of the inventor of the new lamps and lenses, an engineer, who was so liberal as to furnish me the printed reports and drawings on this subject; also the working drawings for the lamps and lenses, at Toulon, which he had then just completed. He also had a lamp of the first order, containing three concentric burners, with the lenses, fitted up and lighted for my inspection; it was the most brilliant light I ever saw. I was informed that the light at Bordeaux had been frequently seen from masthead thirty miles. These drawings I sent home and have them now. They were exhibited to Mr. Pleasonton, at Washington, superintendent of lights, with a proposal to import a lamp and lenses from France, which would cost \$150 to \$200, but met with no favor, much to my chagrin. I thought the information valuable, and had indulged the pleasing anticipation of benefiting our country, but the officers of Government appeared to have other occupation than listening to improvements of this character. As to the comparative merits of our lights and those of other countries, I should think the masters of the packets could give clear and decided evidence.

* Hon. Joseph Grinnell, Representative in Congress for many years from the New Bedford district.

† Brother of the inventor.

NEW YORK, October 1, 1838.

DEAR SIR: We received your letter of the 29th. The light-houses on the coasts of England and France are so immeasurably superior to those on our own coasts, that no comparison can be made. The subject was reported on at the last session of Congress by Mr. Davis, of the Senate, who recommended the investigation now in progress; and Captain Perry's visit to Europe has, for its principal object, an investigation into their light-house systems. The fact is, our whole system needs a thorough revision, and doubtless will have it. There is little or no check as to the quality of the oil, and the forms of the reflectors are defective; and, in some cases, (to make the matter still worse,) imperfect lenses have been placed before the lights—or, rather, pieces of glass called lenses.

The head of this department at Washington has fallen into the singular and absurd error of stating the distances the lights may be seen far beyond what the curvature of the earth will allow; and the heights being well known and given, this is a matter not of speculation, but of absolute certainty.

We have lent to the officers engaged this way, in the same business, our light-house books.

The measure of the reflectors should be taken, to see if they are, in fact, parabolas, and all of the same figure. We have little doubt but that you will generally find the keepers to do their duty, and keep their lamps, &c. in good order; but this is a minor point.

Respectfully yours,

E. & G. W. BLUNT.

Lieut. WM. D. PORTER, U. S. Navy.

Extracts from "Notices of Light-houses in the United States."

BY CAPTAIN M. C. PERRY, U. S. N.

Under the present light-house system of the United States, the light-houses, light-boats, buoys, and beacons are placed by the Treasury Department in charge of the collectors of the various ports, who are required to visit and inspect them, at convenient seasons: to see that the respective keepers are faithful in the performance of their duties; that the contractors for oil, lamps, &c., conform to the letter of their contracts; that the public property is kept in good repair and preservation. Now, it must appear evident to every one that, however desirous the collectors of the great commercial ports may be to fulfil this part of their official duty, with proper regard to the public interest, it is utterly impracticable for them to do so, for the reason that their whole time and attention is absorbed in more urgent duties. Some of the collectors of the minor ports, whose limited occupations at the custom-house may allow them leisure to examine with due care the light-houses under their particular charge, doubtless endeavor to fulfil the trust, but that the collector of the port of New York, for instance, who is charged with the superintendence of ten or twelve light-houses, and a great number of buoys, beacons, &c., some of them placed at distances of more than two hundred miles apart, can possibly give any of his valuable time to the business, is, according to our view, entirely out of the question. The collectors of Boston, Philadelphia, Baltimore, Charleston, Savannah, Mobile, and New

Orleans, though having less of the public revenue passing through their hands, must be equally occupied at their several offices.

Admitting, then, that the collectors of the smaller ports may find leisure and inclination to inspect the light-houses, &c., within their respective districts, and those holding similar appointments at the large commercial cities *cannot*, it follows that the light-houses of *least* importance are *supposed* to be attended to, while those lighting the channels to our great commercial resorts are unavoidably neglected.

We do not mean to impute to the Treasury Department or the collectors the slightest intentional neglect; on the contrary, it must be a matter of surprise that, under the present organization of the light-house system, the department at Washington has been able to preserve so much order and economy. When we consider the multifarious duties imposed upon the Secretary of the Treasury and his assistant Auditors, labors certainly sufficient to authorize in Europe the establishment of a half dozen bureaux, we cannot but be astonished that the superintendence of light-houses should be added to their already overwhelming responsibilities.

It is desirable that the present executive and financial departments of the system should be retained; that the Secretary of the Treasury should continue as the chief director of the whole; the Fifth Auditor still exercise his experience in the management of its civil and financial concerns, and the several collectors act, as heretofore, as agents and disbursing officers; but here their *immediate* personal agency should cease. *So far*, the system is unobjectionable; but to render it completely so, nautical men should be employed to superintend those matters that belong more exclusively to the profession. Light-houses, as well as floating lights, buoys, and beacons, are placed for the safety and convenience of seamen; and none but seamen are capable of appreciating the importance of a proper vigilance in the management of these indispensable guides. There are numerous contrivances and modes of communication, known only to the seaman, by which the masters and pilots may be directed, in times of anxiety and danger; and for this and other reasons, none but retired ship masters and mates should be appointed as keepers of lights, whether ashore or afloat.

It is necessary, also, that practical seamen should be employed to anchor the floating lights and buoys, to see that they do not move from their positions, and to inspect, from time to time, the moorings by which they are secured.

Hitherto, the collectors, from their ignorance of such matters, have generally delegated the business of putting down buoys to pilots; who, in the execution of the charge, as it might be expected, have taken care to place them to suit their own convenience, and to disregard the convenience of others. And with respect to light-houses, the same falsity has prevailed, at all events, in this vicinity, where pilots have always been the principal operative agents.

With reference to the existing mode of superintending the various light-houses, we would ask who visits and inspects them? Who sees that the oil is of the best quality? that the buildings and grounds are preserved from injury? It may be said, in answer, the collectors; but this is not the fact. In very many of the light-houses, the whole charge devolves on the keepers, upon whose attention and integrity depend the good or bad condition of the establishments entrusted to their care. Many of these people are, doubtless, faithful in their duties; others not so.

The contractors visit, at stated seasons, the light-houses for the purpose of delivering oil, examining and exchanging such of the reflectors, lamps, &c. as need repair. By the contracts, these are required to be kept in the best possible order, and the oil to be of the first quality. Now let us inquire, Who inspects the oil when delivered? Who decides upon the condition of the reflectors and lamps? We answer, in most cases, the keepers. We know, from personal examination, that many of the reflectors and lamps, in several of the light-houses, have no spare reflectors; and when it becomes requisite that one should be repaired, it is necessarily sent to an artizan at a distance,* and is sometimes kept away for weeks; thus the brilliancy of the light is diminished, and the anxious mariners made to suffer the consequences.

By a clause of the contract, the contractor is required, when making his annual visit to the light-houses, to deliver oil, &c., to examine into the condition of these establishments, and to report to the Treasury Department whatever of impropriety or neglect may come to his notice. Now, without impugning, in the least, the honesty of the contractors, or the fidelity of the keepers, we may be permitted to remark, is it reasonable to suppose that the whole truth, in regard to these required examinations, is always communicated? In most cases, the keepers are the inspectors and receivers of the oil. They are left to judge, and, if necessary, to complain of the unfaithfulness of the contractors, and the fulfilment of their stipulations. Then how can it be expected that the parties, thus made dependant upon each other for the transmission to the treasury of reports, whether favorable or unfavorable, of the performance of their respective obligations, should very often exhibit cause of complaint?

But for all these evils there is a simple remedy, which can be applied without deranging the main organization of the system. And this is, to establish a board of inspectors of light-houses, &c., to be composed of four or five naval captains, and one engineer. Each of these captains to be charged with the inspection of the light-houses, floating-lights, buoys, and beacons, within the boundaries of *one of four* light-house districts, to be arranged in the following manner:

The *first district* to extend from New York to the eastern confines of the United States.

The *second*, from New York to Savannah.

The *third*, from thence to the southern boundary, embracing all the navigable bays, sounds, and rivers, communicating with, or disemboing into the Atlantic, within the geographical limits of the respective districts.

The *fourth*, the lakes and western rivers, wherein light-houses, buoys, or beacons are, or may be established.

These officers should be temporarily detached by the Secretary of the Navy for this special duty, and placed under the orders of the Treasury Department. The engineer should be *exclusively* attached to the same department.

It should be the duty of the inspecting captains to visit and inspect, once in every year, and oftener if necessary, every light-house, floating-light, beacon, and buoy, within his respective district, and to make full and com-

* This information the writer received from the keeper of a light-house in the New York district.

plete reports to the Secretary of the Treasury of the condition of the whole, with such suggestions of improvement as he might consider advisable.

The duty of the engineer should be to furnish, under the instructions of the Treasury Department, plans and specifications for such new works as might be authorized by Congress; to superintend the repairs and alterations suggested by the inspecting officers, and sanctioned by the department; to attend to the purchase and arrangement of lenses, reflectors, lamps, &c., and to the inspection of the oil and other articles required.

It will be perceived that, by this arrangement, no changes are proposed in the administration of the light-house department; but simply an enlarged system, by which those who at present conduct that branch of the public service would have efficient aid in the fulfilment of their important duties. In truth, the light-house board would be nothing more than an appendage of the Treasury Department, acting under its authority.

As naval men, they would be always competent to the duty, and while employed in their tours of inspection, would necessarily, as a part of their business, become familiar with all the peculiarities of the coast, the various shoals, channels, and harbors; an advantage of the highest consideration, and which at some future time might prove to them as commanders of vital importance, and possibly be the means of saving them from shipwreck or capture.

The employment of the proposed board would impose no additional expense on the government, nor would it interfere in the least with the naval duties of the captains. On the contrary, a saving would be effected by the increased care and vigilance of the light-house keepers; and the naval captains, as we have before remarked, would be immeasurably benefitted by the valuable hydrographical information obtained; and should one or more of these captains be wanted by the Secretary of the Navy for command or other duty, others could be conveniently ordered to fill the vacancies, thus giving to each in turn the benefit of this instructive service.

If the engineer to the board should be taken from the corps of engineers, then, of course, he would receive his usual pay, in like manner with the captains, from the particular department to which he belongs; but if especially appointed for this duty, his salary might be considered as an additional charge upon light-houses, but it would be more than balanced by the saving produced by his services in furnishing plans and specifications, superintending repairs, &c.

M. C. PERRY,
Captain United States Navy.

Extracts from the report of Mr. Davis, from the Committee on Commerce of the Senate, May 10, 1838. (Senate Document No. 428, 1st session 25th Congress.)

By the report of the navy board, it appears that they have arrested the erection of no less than thirty-one of these proposed light-houses, for reasons which are assigned by the officers employed in that service, which seem fully to justify the following remarks in the concluding part of the report: "When the great importance in the light-house system is considered, in relation to the safety of human life and of vast amounts of property, to the

facilities and rapidity of communication which it gives between different parts of our extensive Atlantic and lake coast, and to the cost of establishing and supporting it, the board would respectfully suggest whether some additional measures may not be desirable for obtaining the necessary information to secure the greatest public advantages from the expenditures which may hereafter be authorized for these purposes."

The committee fully concur with the navy board, that legislation should proceed upon more safe and satisfactory information. Hitherto, Congress has had before it, when proceeding to authorize the erection of new houses, little information beyond the loose, irresponsible statements of petitioners; most, and perhaps all of whom were, in many instances, unknown; and there is too much reason for believing that those most active in getting up these petitions have been persons interested in their success, that some importance might be given to an unfrequented harbor where they had lands; that they might be made superintendent of the lights, or make sale of the sites, or get a contract, or be benefited in some other way which had no connexion with the public interest beyond making it subservient to their own. It is time to adopt a course less liable to imposition, and better suited to the importance of maintaining an efficient, useful system of lighting our maritime and lake frontiers. In proportion as the approaches to the coast are perilous, so do the rates of freight and insurance increase, and these are charges upon merchandise which are ultimately borne by the consumer. So, also, are freights higher or lower in proportion to the duration of the voyage. If, therefore, in our interior waters, consisting of the great bays and sounds along the coasts which are filled with coasters and steamers, we keep up lights so that vessels can run in the night, the charges for freight are diminished, and the loss of time in travelling is greatly lessened, and the consumers are again benefited, for all charges on trade fall on them. In whatever aspect these facilities which give despatch to commerce and navigation are viewed, the great ultimate advantages result to the public. It is, therefore, a high duty in Congress to watch over these improvements, and prevent their being perverted to individual and selfish purposes, and to make them as complete in their character as any reasonable expenditure of public money and the state of science will permit.

In order to place this matter fairly and fully before the Senate, the committee will give a brief account of our own system and that of France, which is believed to be as perfect as that of any European State, and then the difference, both in the mode of illumination and of conducting the systems, will be apparent, and we shall be able to judge how far their experience may be turned to useful account.

The law has hitherto confided the care of light-houses, floating-lights, beacon lights, &c., of which we now have 238, chiefly to the discretion of the Secretary of the Treasury. It has been usual to add considerably to the number, by law, at every successive session of Congress, and the annual expense of maintaining them for the year preceding the 1st of July last, was \$208,072. The system has, therefore, increased under an irregular course of legislation, accommodating itself gradually to the growth of the country, till it has become in all respects highly important.

The collectors of the customs, to the number of forty-four, have, by the appointment of the Secretary, (for which there is no legal provision,) the general superintendence, each within a district assigned to him, for which compensation of two and a half per cent. on his disbursements is allowed,

not to exceed \$400 to each annually. The keeper assigned to each house or boat derives his authority from the same source.

The houses are generally of stone or brick, and since 1812 have been illuminated by Argand lamps, varying in number from four to twenty-one; the intensity of the light being greatly increased by the parabolic reflectors of Mr. Lewis, to whom the country is indebted for considerable improvements upon the means before employed in lighting the houses.

There is much reason for believing, however, that while our system (if system it can be called) has, probably, most of the time, been conducted with reasonable care and satisfaction to the public in most respects, that both the French and English have, by scientific research and improvement, perfected theirs to a considerably higher degree.

The French have taken the lead, and are chiefly indebted to the high attainments and spirited zeal of M. Fresnel, who brought into successful practical use the lenticular apparatus, instead of reflectors. This apparatus is called dioptric, while that of reflectors is denominated catoptric; and where both are combined, as occurs in some instances, it is distinguished as dia-catoptric.

Of the dioptric lights the French have four classes, which indicate the power or intensity of light. The lenses are arranged in an annular form, and an Argand burner, with four concentric wicks, is placed in the centre for the first class. The second has a burner of three concentric wicks, and so on. They appear to be rapidly superseding the reflectors in France, under the conviction that they afford a more brilliant, equal, and economical light.

The general supervision of light-houses, &c., devolves on the Minister of the Interior; but no new light can be established without the concurrent opinion of this minister and the Minister of Marine.

Subordinate is a *Commission des Phares*; the members of which, except the Secretary, receive no compensation. It has hitherto consisted of certain civil engineers, employed in the administration of roads and bridges, naval officers, and astronomers, with the late distinguished M. Fresnel as secretary and chief engineer. The design of such a combination is manifestly to bring to the public service the requisite qualifications to select the best sites, to construct the most suitable buildings, and to bring into use the most perfect and scientific apparatus.

The plans for buildings, except in the manner of fitness for lights, are submitted to the general council for the administration of roads and bridges; while all important improvements in lights are submitted to the whole board. The secretary and chief engineer manages the details, and keeps a constant and vigilant eye over the whole. The organization appears to be highly judicious, and the system is, as the committee believe, conducted with great success.

In proof of this, they will bring to view the opinions of several enlightened individuals.

In 1835, Mr. Stevenson, who is understood to be the general superintendent of Scotch lights, was authorized by the commissioners of northern lights to examine the French dioptric lights. He states in his report, that he visited many of them, to which he had unrestrained access; saw them in full operation; and was made acquainted with the apparatus by M. Fresnel, who answered all his inquiries with the most liberal frankness, and instructed the keepers to do the same.

Upon a full examination under such favorable circumstances, and a free inspection of the manufacture of the apparatus, the result was decidedly favorable to the lenticular plan, because of its power, its admirable diffusion of light, and its economy.

He affirms that any given quantity of oil will give out at least three times as much light with the lenticular apparatus, as with the parabolic reflectors, while it is diffused equally in a plane around the whole horizon, which is a most desirable arrangement, and has never been attained with the reflectors. After going through the details of estimating the annual expense of dioptric and catoptric lights, he uses the following language: "Thus it appears that the annual expenditure of the dioptric fixed light is £88 3s. 8d. less than that of a fixed light composed of twenty-six reflectors; and the light given out is three times more powerful, while at the same time it is more equally diffused over the horizon."

Afterwards, a committee of the Royal Society, appointed to co-operate with the commissioners of northern lights, met in October, 1836, to examine the new dioptric light on the Isle of May, and to compare it with the old catoptric light near it. The observations were made at a distance of thirteen miles; and the committee report that the following conclusions seem to be warranted:

"1st. That at a distance of thirteen miles, the mean effect of the new light is very much superior to the old light, (perhaps in the ratio of two to one.)

"2d. That at all distances the new light has a prodigious superiority to the old light, from the equality of its effects in all azimuths.

"3d. That the new light fulfils rigorously the conditions required for the distribution of light to the greatest advantage.

"4th. That at distances much exceeding thirteen miles, the new light must still be a very effective one, though to what extent the committee have not observed. The light is understood to be still a good one when seen from Edinburgh, a distance of about thirty miles."

The learned and distinguished Dr. Brewster, after examining the subject fully, holds this language: "Hence it follows that the lens apparatus is in every respect better and more economical than the reflector apparatus;" and again: "The lens apparatus is far more intense than the reflector apparatus of the same size; with the same intensity of light, it consumes much less oil; in reference to the original cost, repairs and renewals, it is more economical; it requires a less expensive light-room, and demands much less time and trouble from the keeper, while it possesses the property (which reflectors never can have) of admitting every variety of resource in cases which demand extraordinary illuminations."

The committee find at page 72, Senate document 138, present session, an extract from a French document, which has in it the following language: "From numerous experiments made comparatively on several apparatus of the old and new system, it is satisfactorily demonstrated that a given quantity of oil employed in the illumination of light-houses, (lenticular,) gives *from three to four times* more useful light, that is transmitted horizontally, than if this same quantity of oil was consumed for illumination of the best apparatus with reflectors."

The committee might add much more concurrent testimony from equally reputable sources, tending to prove the superiority of the French system;

but being satisfied with this, they forbear enlarging on this head, and will now consider what is necessary to constitute an effective system.

1. The sites for light-houses and light-boats should be selected with great care and judgment, for the illuminated point should be that which earliest and most certainly indicates the danger to be avoided, and affords the safest guide along the channel. Nautical and hydrographical knowledge is obviously essential to a successful discharge of this duty. There is much reason for believing that many errors have been committed in the United States by the selection of improper sites; and it is said that some lights have been extinguished for this reason.

2. The houses should be made of incombustible materials, and of such elevation above the level of the water as to be seen far enough to admonish the navigator before he falls into peril. They should be of a form adapted to the apparatus to be employed for illumination.

3. The kind of light should be such as to enable navigators to identify it at first sight from all others. This is of the first importance, as any mistake in the recognition of a light is quite as likely to end in disaster as safety. The committee have heard complaints on this head, that our lights are in some places either too numerous, or not so distinctly characterized as to be readily distinguished from each other. It is well known, that at several points on the coast, no less than five or six, or perhaps even more, may be seen by a vessel at the same time; and though, doubtless, they are generally readily known by those to whom they are familiar, yet others have found themselves embarrassed.

In the description given by the French government of their light-houses in 1837, the committee find the following account of their means of discrimination: "The fires of the light-houses and watch-lights may be arranged according to their distinctive characters in three principal classes, namely: fixed lights, eclipsing or revolving lights, or those which alternately appear and disappear, lights varied by great brightness, preceded and followed by short eclipses.

"1st. The fixed lights differ only in their greater or less intensity, with the exception, however, of the little red light on the northeast stockade of the port of Boulogne.

"2d. The eclipsing lights, called also revolving lights, offer no very marked difference, except in the duration of their phases. They are produced regularly, at intervals which vary from half a minute to two minutes and three-quarters.

"The bright light or flashes, (*eclats*,) which alternate with eclipses in the lights of this kind, acquire at the end of some seconds, their maximum of intensity, and decrease afterwards by the same gradations.

"When we are sufficiently near a revolving light, its eclipses no longer appear to be total, as we perceive, in the interval between the flashes, a light of much less intensity.

"3d. The lights varied by great brightness belong exclusively to a particular kind of lenticular light-houses. The longest period of the appearance of the light of this apparatus, presents a flash more or less brilliant, which, after a certain interval of time, gradually grows weaker. To this decrease of light (which, to the observer, placed at a sufficient distance, becomes a *total eclipse*,) succeeds, during some seconds, a bright light much superior to the first. This great bright light afterwards decreases, and the fixed light reappears.

“The changes in the appearance of the light take place regularly, at intervals which vary from two to four minutes, according to the disposition of the apparatus.”

From this and other statements, the committee infer that the French avoid the use of colored lights, because white lights are supposed, in a fog, to appear so discolored as to mislead the navigator, and to rely wholly on white lights, which are fixed or revolve, and are eclipsed or send out flashes at regular intervals, some longer and some shorter, but each having a length of interval different from all others; and therefore is identified by the time, as well as the brightness or feebleness of the flash, according to the power of the light. The committee have heard of no practical inconvenience from this arrangement, though it is obviously less distinctive and marked in its character than colors.

On this point Mr. Stevenson remarks, that “as the sole object in establishing a light is to make known to the benighted mariner the land he has made, with as much certainty as the sight of a hill or tower would show him his position during the day, it becomes an object of the first importance to impress upon each light a distinctive character, which shall effectually prevent the possibility of its being mistaken for another.

The leading characteristic distinction in the Scotch lights is color. They employ, in all, six classes, namely: Fixed, revolving white, revolving red and white, flashing, intermittent, and leading lights; alleging that in practice they meet with no inconvenience or perplexity in the employment of colors.

The committee have been thus minute on this head, because it is obvious that, however perfect lights may be, they can be of little practical utility unless readily identified; and it is equally plain that those which assimilate in character or appearance should be placed as remote from each other as possible.

4. The power of lights should be proportionable to the distance at which they ought to be visible, to give early notice to the navigator. Those first seen, in approaching the coast, should usually be of the first class, as they constitute the outer range, and are sea lights. Those upon the close waters may be of sizes proportioned to the object to be attained, as they serve as guides into harbors and along our bays, sounds, and inlets through which our vast coasting trade passes. These waters, like great streets, may be so lighted that vessels of all classes may pursue their voyages by night as well as by day. Indéed, those most frequented are now so lighted that steamers and coasters run with safety by night; and thus the traveller is expedited, and the duration of voyages lessened.

5. The oil should be of the first quality; and we cannot too vigilantly guard against the introduction of inferior qualities, for with such it will be in vain to hope for intense light from the best apparatus. The French use vegetable, while we use sperm oil.

6. The keepers should be persons of untiring fidelity and vigilance, as on the prompt and faithful execution of their duties depends the lives and property of their fellow citizens. They should have a perfect knowledge of the apparatus, and all the most approved methods of keeping it in the most effective order. These are very important considerations, for if cleanliness be neglected, or it be suffered to get out of order, ordinarily the intensity of the light is impaired, and consequently its usefulness.

7. The lights should be frequently visited by a general inspector who

is master of the whole subject, being fully capable of estimating the true character of the apparatus, its condition, the manner in which it is managed, whether the keepers are capable and faithful, and whether the oil is such as it should be. In a word, this visiter should be so thoroughly skilled in everything pertaining to the subject, as to keep the light-houses in as perfect a condition as the arts and the progress of science will allow. This great and important duty in France has hitherto, it is understood, devolved upon the secretary and chief engineer of the Commission des Phares ; and to the late M. Fresnel, who filled that office, we owe a debt of lasting gratitude, as a common benefactor. We have already said certain collectors of the customs are the inspectors of the light-houses within their respective districts. It is manifest the two offices have no natural connexion, for they require qualifications quite dissimilar. The one should understand the laws of light, as it is affected by reflectors and refractors ; the other, the character and value of merchandise. And there is no affinity between the employments ; nor does it follow that one who is well qualified for a collectorship has a particle of that information which is essential to a well-conducted system of lights. Again, the number is great ; this duty is merely collateral ; their visits are seldom ; their attention little engaged in the matter. They have no control over the system, have no knowledge beyond their districts, and the consequence is that their inspection is generally of little importance, and has little tendency to expose the faults or improve the character of the system. Indeed so necessary is some other inspection, that the contractors who furnish oil are required to view and report upon the condition of each light, and so also are the immediate keepers. The subject was early committed to the supervision of the collectors, as a matter of convenience ; but we may well inquire now whether its importance does not call for a more skilful supervisor—one that can give harmony and character to the whole system, and make it not only keep pace with the progress of population and business, but with the advancement of mechanical and scientific improvements.

Such are the general outlines of what the committee consider essential to an effective system of light-houses, light-boats, beacon-lights, &c., and it will be perceived, from the course of remark, that the committee believe ours may be improved both in lights and in organization.

The committee are disposed, however, to attribute these results more to improvident legislation, and the want of suitable legal provisions, than to any other cause ; but they believe that this is as favorable a moment as any which will occur to begin reformation. The great lake coast is pressing heavily for improvements, as well as the southern Atlantic coast, which greatly needs more and better lights. The track from our commercial cities to the mouth of the Mississippi has become a vast highway, bearing upon its intricate channel, which is beset with storms and currents, a trade of great magnitude, which is destined to go on increasing. It is a matter of high importance that lights should be scattered along this track, and that the perils of navigation should be lessened by all suitable measures within our power. New light-houses have been and will continue to be demanded in this direction, and they ought to be of the most improved kind.

The committee are satisfied from the evidence before them, derived as it is from the most authentic and respectable sources, that the lenticular apparatus is the best in use ; but, to test the matter and place the truth or falsity of the statements beyond all doubt, they recommend an appropria-

tion sufficient to import two sets of the first class of apparatus, to be placed at two of the most important points on the coast, where navigators may at once decide upon their character as compared with the old lights; and also one apparatus of the second class, to be put up at some point also to try its merits.

The committee would further recommend, as a preparatory step to a better organization of the whole system, that the coast be divided into such districts as the President may deem convenient for the purpose, and that a sufficient number of naval officers be detached to survey and examine the light-houses, light-boats, beacon-lights, buoys, &c., and to report upon their present condition and usefulness, and also what improvements in their judgment the public emergencies demand. It is desirable, if convenient, that two officers at least should be assigned to each district; and that each board, after having made the survey and examination, shall also suggest modifications in the future organization of the light-house system, if in their opinion any change is expedient.

To carry into effect these measures, the committee request their chairman to move the subjoined as an amendment to some appropriation bill making provision for objects that harmonize in their general character with this.

AMENDMENT.

Fifteen thousand dollars to enable the Secretary of the Treasury to import two sets of dioptric, or the most improved lenticular apparatus of the first class for light-houses, and one set of the second class, and to place them in light-houses where their value, as compared with the apparatus now in use, may be most speedily and effectually tested by the observation of navigators. And, to the end that Congress may be furnished with more exact information in regard to light-houses and the light-house system, the President shall appoint such a number of naval officers as in his judgment is necessary to survey and examine the Atlantic and lake coasts, whose duty it shall be to report upon the present condition and usefulness of the light-houses, light-boats, beacon-lights, buoys, &c., designating such further and additional works and improvements as the public emergency most urgently demands; and also whether the public interest demands any, and if any, what modification of the system to render it more effective and useful. And the President shall, if he sees fit, divide the coast into districts, assigning such officer or officers to each district as he thinks proper, always assigning two to each district if the public service will allow of it, and each board shall report as above provided.

Document in relation to the mode of lighting, and the general management of the light-houses, light-ships, &c., of the United States. (July 7, 1838.)

The subscribers, a committee appointed by the Chamber of Commerce at a regular meeting held on the 5th ultimo, to examine certain documents and reports made to the Senate of the United States relative to the mode of lighting, and of the general management of the light-houses and light-ships, &c., of the United States, beg leave to report:

That, from a careful examination of these reports, and from the evidence

furnished by the testimonials of shipmasters, inspectors of insurance companies, and others well acquainted with the subject, they are satisfied that the mode of lighting and the general management of the light-house establishments of Great Britain and France are greatly superior to those of the United States.

That it also appears that various alterations in changing fixed lights to revolving ones, and in altering the position of light-ships, have been made; that new light-houses also have been built and lighted, and in some cases no previous notice given, contrary to the practice of other maritime countries; and it is the opinion of your committee that many losses have taken place and ships frequently been endangered for the want of such notices.

That, in the opinion of your committee, it should be made imperative on the superintendent of lights to give through our consuls abroad, and by every practicable means in his power, as long previous notice as possible when the erection of any new light-house or any change in the mode of lighting is determined on.

That the report made to the Senate of the United States is favorable to the adoption of a plan for the improvement of the present light-house system. In this report it is recommended that naval officers be appointed to make the necessary surveys and examinations, and to report what improvements, in their judgment, are necessary; and it also further recommends that two sets of lights of the most improved construction be imported and placed in such situations as that they may be compared most effectually with those now in use.

The committee, therefore, recommend the following:

Resolved, That, in the opinion of the Chamber of Commerce, some alteration in the mode of lighting and of managing the light-houses, light-ships, &c., of the United States is necessary; they approve of the report submitted to the Senate by the Committee on Commerce on this subject, and of the recommendations contained therein.

Resolved, That a copy of the above resolution be forwarded to the chairmen of the Committee on Commerce of both Houses.

ARCH. GRACIE,
HENRY W. HICKS,
MOSES GRINNELL.

Extract from the report of Lieut. Thomas J. Manning, U. S. Navy.
(Doc. H. R. No. 24, 3d session 25th Congress.)

"During the survey of the coast, eight out of nine of the light-keepers have complained of their oil being thick and burning badly, and I would recommend adopting a different mode to supply that article, which is of high importance to be the best, as the weather is severely cold during the winter season in that climate. Would it not be better if it were purchased by government, and have a government inspector, whose duty it should be to supply the oil and examine the lights? This could all be performed by a small vessel, and I think much money might thereby be saved to the government. The collectors, whose duty it is to visit the lights, can perform but one visit a year, and consequently the lights are much neglected for want of strict observation.

"I have conversed with many ship-masters on the subject, and found no difference of opinion—that there are too many lights in sight at one time in some places on approaching the coast; and I would recommend that some of them be removed. In two different places on the coast, there are nine lights to be seen at one time, which must confuse the navigator. In many other places there are five or six, and sometimes seven lights in sight. It may be that all the lights on the coast of Maine are required, but I should suppose that some of them might be dispensed with. This will require long observation, (say the whole season,) to ascertain their proper position.

"All the lights require distinction. They should be colored or made to evolve, or something to recognise them in a dark night. All this requires much observation, and is of great importance on the coast of Maine. A navigator on this coast is destitute of a correct chart; there is but one and that is unfinished; it cannot be depended upon; it only embraces the coast of Maine."

Extracts from the report of Lieutenant George M. Bache, U. S. N., November 22, 1838. (Doc. H. R. No. 24, 3d session, 25th Congress.)

* * * * *

Some systematic mode of designating the positions of buoys would be of great utility, more especially should an increase in their number be authorized. Such distinctions as will show on which hand a buoy is to be passed, whether it be on a rock, a detached shoal, or at the end of a spit, will assist even those who may be familiar with the navigation, and are particularly serviceable in narrow and tortuous channels.

To produce the best results from this, simplicity must be preserved, and, at the same time, a sufficient number of distinctions introduced. I would beg leave to suggest the distinction of colors, as being the most applicable, and refer to the accompanying chart, which displays the simple combinations of color deemed most advisable. On sailing up a sound, bay, or channel, or entering a harbor, all the buoys on spits extending from the shore, which are to be left on the right hand, are painted red; all those on the left hand are painted black. Those on rocks, or very small shoals, around which there are channels, are painted with alternate red and black rings; these, as their color would indicate, can be passed on either hand.

On the shoals, which are included between two buoys, the lower and right-hand buoys are painted with alternate red and white rings; while the upper buoys, and those to be passed on the left hand, are black and white. The red and black colors also indicate on which hand they should be left; the white being introduced merely to designate a detached shoal. This system is applicable to all the waters of the United States; the colors red and black have been selected on account of showing best upon the water; and as all buoys are now painted, there can be no objection to it on the score of economy.

* * * * *

By a clause in the third section of the act, the officers making the inspections under it are required also "further to report whether, in their judgment, the public interest requires any modification of the system of

erecting, superintending, and managing the light-houses, light-boats, &c., and if so, in what particulars." The fulfilment of this duty is entered upon with diffidence, after a due consideration of the magnitude of the interests affected by the proper organization, efficiency, and economical administration of the establishment in question.

In order to present the subject properly and in a connected form, it may be well to take a hasty view of the progress and management of the light-house establishment from its origin to its present organization, detailed in authentic public documents.

It appears that immediately after the formation of our government, and prior to the year 1789, the few light-houses then existing were maintained at the expense of the States in which they were situated. By an act of Congress passed in 1789, the expense of their maintenance was assumed by the United States, and their management confided to the Treasury Department, with which it has ever since remained. The first light-house erected by the general government was that upon Cape Henry, in 1791; and from that date to the year 1800, eight new lights were established, making the total number sixteen. They were placed upon the most frequented and dangerous points of the northeastern and middle portions of the Atlantic coast; three of them are within the present third district, and will be more particularly referred to. Prior to the year 1812, the number of light-houses had increased to forty-nine, and their establishment extended along the southern coast to Louisiana; the buildings were generally constructed by contract, and were inspected, before being received, by the superintendents of the districts in which they were situated. The lanterns were furnished with common spider lamps, without lenses or reflectors; and the oil for their use was stored in the custom-houses, and delivered at the light-houses as it was required.

In the year 1812 an improvement was made in the lighting apparatus, by the substitution of the Argand lamps for the common lamps then in use, and the addition of metallic reflectors. This was effected by a contract entered into by the Secretary of the Treasury with Mr. Winslow Lewis, of Boston, by which the United States purchased of Mr. Lewis his "patent-right to the plan of lighting light-houses by reflectors and magnifying lanterns," for the sum of \$20,000; the contractor agreeing to fit up, according to said plan, all the then existing light-houses, and those that should be established in the following two years, so that the new apparatus should give a more brilliant light, with a supply of one-half the oil formerly consumed; the expense of materials, making, and fitting the apparatus being borne by the United States. The reflector then introduced, and to a great extent still in use, is made of copper, plated with silver on its concave surface, which is modelled into the shape of a paraboloid; this reflector is similar in form and material to those placed in the light-house at Inchkeith in the Frith of Forth, in the year 1803, and is similar in form to those composed of facets of mirror glass, which were in use in the Scottish lights as far back as the year 1786. The lens employed in conjunction with the Argand lamp and reflector is a mass of impure-glass weighing over eight pounds, and has already been described in the account given of light No. 1.

Up to the year 1822 the number of light-houses had increased to seventy; they were supplied with oil, &c., under a contract entered into with Mr. Lewis, who received from the United States one-half the oil previously consumed in their maintenance. Contracts for oil have since been made with

other individuals; and differ from this, by substituting a certain sum for the maintenance of each light in lieu of the former mode of payment.

At the commencement of the present year, there were in operation upon the seacoast, and the shores of the great inland waters of the United States, two hundred and four light-houses, together with twenty-eight light-boats, which are placed near dangerous reefs and shoals, where it is difficult or impossible to procure a secure foundation for a permanent building.

The system under which this establishment has thus increased, and is at present conducted, it is now necessary to examine; and, in so doing, the facts elicited by the examination of the lights will be referred to, in order to show its practical operation; seeming defects in the system will be pointed out, and, in obedience to my instructions, such propositions made for its modification as the public interest may appear to require.

The authority for establishing a new light-house is derived from the act of Congress making the appropriation for its erection; such appropriations are generally made upon the representations of petitioners that, by the object proposed, the navigation in its vicinity will be benefited. Prior to 1837, no strict inquiry appears to have been instituted in order to ascertain the necessity for establishing the new lights applied for, the amount of benefit to be derived from them, or the injury liable to be produced by their multiplicity; and as the check upon improper applications, created by the imposition of a direct tax upon vessels passing a light, does not exist in this country, it is not surprising that light-houses have been applied for, and placed in situations where the service rendered by them has not warranted the expense of their construction and maintenance; and by those acquainted with this mode of application, it will easily be understood why the comparatively safe shores of populous districts are seen in many instances studded with lights, while on the unsettled though much frequented and dangerous portions of our seacoast they are of much rarer occurrence. This defect in the light-house system has already attracted the attention of Congress. By one of the sections of the act making appropriations for new lights in the year 1837, it was provided that, before the improvements specified in the act should be commenced, an examination of their proposed sites should be made, and their usefulness inquired into and reported favorably upon by the Board of Navy Commissioners. By the operation of this provision of the law, the construction of thirty-one of the proposed buildings, involving an expenditure of \$168,700, was suspended; but while a strict examination of this nature will arrest the construction of buildings of little or no utility, something further appears to be required in order to render the system more equal in its operation over the different portions of the country.

The appropriation for a building is not founded on an estimate made after having the proper site selected, and the plan of building calculated for it drawn up; but the building is made according to the appropriation and site. In some instances, the appropriations have not been sufficient, and works of real importance have been delayed; in others, unsuitable buildings have been erected, in order to bring their cost within the sum to be expended. A light being authorized, the site for it is selected by the superintendent of the district under which it falls; this superintendent is always a collector of the customs; but the duty which thus devolves on him often requires the peculiar knowledge both of the engineer and seaman. The nature of the foundation, the action of the sea and the currents in its immediate neighborhood, are among the subjects which require the consideration of the former; while

the selection of that position from which the light would afford the greatest assistance to the mariner, is peculiarly the province of the latter.

The destruction of much public property might have been prevented by a more judicious selection of these sites, and the public interest evidently demands a reform in this particular. In most instances, the plan of the building is furnished from the office of the Fifth Auditor, and the superintendent of the district advertises for proposals to build, in accordance with it. A suitable mechanic is then employed to see that the work is properly done, and upon his certificate, it is accepted. It cannot be denied that, under this system, many buildings have been badly constructed. Within the third district, it is seen that the houses or towers at lights Nos. 4, 7, 21, 23, 26, 28, and 29, are of this description; and the beacons which were destroyed at Black Rock and Bridgeport also afford striking instances of the misapplication of the public money. All these works, built under the economical system of contract and intended to be permanent, have not stood the proper test of true economy. The check upon contractors imposed by the supervision which has been referred to, has had but little effect in securing good workmanship or the faithful performance of their contracts; and it is worthy of remark, that the oldest buildings are now in the best condition—the towers, in particular, of lights Nos. 9, 14, 24, and 13. The three first erected at the close of the last century, afford a striking contrast to many of those of very recent construction.

The light-boats are built under the same contract system, according to plans furnished from the office of the Fifth Auditor, and it is found that on the southern coast, particularly, they are so much injured by dry-rot in the course of four years, “as to cost nearly as much in repairs as would build new vessels.” The unseasoned state of their timbers is the probable cause of this rapid decay, and indicates the proper remedy to be applied.

The proper adaptation of these vessels to their stations has not always been attended to; this is observed in the instance of light-boat No. 15, which is wholly unfit for the position she occupies, and a want of proper forecast has been shown in the provision for mooring light-boat No. 22. These may be exceptions to the general system, but, having occurred under it, they are deemed worthy of attention.

A light-house being under contract, separate proposals are at the same time received for fitting it, agreeably with Mr. Lewis's lamp and reflector, and every thing necessary to keep up the light. There is no copy of the specifications of the patent taken out for this apparatus in the office of the Fifth Auditor, but it appears that in forty-four of the light-houses first fitted up by Mr. Lewis, lenses were employed with the smallest class of reflectors. Within the third district, they are now in use in light-houses Nos. 1, 17, and 18, and were formerly employed in Nos. 10 and 17. The object of these lenses appears to be to decrease, by refraction, that portion of the direct rays from the lamp which fall upon them; but, at the same time, they receive and refract the rays already reflected from the mirrors. The effect these lenses are intended to produce adds very little to the light; and if it be considered that they are very thick, and generally of very impure glass, it will appear that they must absorb much more light than is made up by it; and when placed so as to increase greatly the divergence of the reflected light, as at lights Nos. 1 and 17, they are of still greater injury.

The use of these lenses has been discontinued, as the apparatus to which they belonged has required renewing.

The paraboloid form is generally considered the best that has yet been adopted for the reflectors of light-houses, that figure having the property of reflecting, in parallel rays, the light radiating from its focus, and producing a divergence or a convergence in the reflected rays, according as the flame from which they proceed is nearer to or further from the vertex of the reflector than the focus. In order to produce the best results from its employment, great care and accuracy are required—

1. In modelling the reflector to the proper form, in securing the permanency of its figure, and giving it a good reflecting surface.

2. In adapting the lamp to the reflector so that its flame may be in the position which will produce the proper divergence of the reflected light.

3. In placing the axis of the reflector in the direction in which the strongest light is required, which is generally on the horizontal line.

Let us examine how these conditions have been fulfilled under the present system.

1. It has been seen that, in some instances, reflectors of a different form from that required by law, have been furnished and received. At lights Nos. 24, 27, 28, 29, and 34, they are spherical; and those in Nos. 1, 2, 5, 17 and 18 are so much bent, that it would be difficult to determine the forms originally given them. This latter defect is owing to the great lightness of the reflectors, as many of them are made of metal of which five, and even eight square inches weigh but a single ounce. In the last-mentioned lights, together with Nos. 4, 6, 11, 16, 19, and 26, the reflecting surface of the mirrors is injured by the abrasion of the silver. In some instances this is effected in the ordinary process of cleaning; and in others it is occasioned by the friction required to free it from the lamp-black deposited, owing to the shortness of the tube-glasses.

2. The reflectors, in some cases, have not been placed in the positions calculated to produce the best effect; the most remarkable instances of this occur in lights Nos. 19, 23, and 26; but the fixtures in many more of the establishments are such that they are easily put out of adjustment.

3. Owing to the imperfect mode of securing the reflectors to the lamps, and the improper fixtures of the latter, which have already been alluded to, it is found that in lights Nos. 1, 3, 7, 12, 17, 21, and 31, the axes of the reflectors are not on the horizontal line, and are generally elevated above it. By this arrangement, the strongest portion of the reflected light is thrown upwards, and can never meet the eye of an observer from the water.

It is apparent, then, that under the present system a moderate degree of efficiency has not been secured, even in the simple catoptric instruments now in use; and while, by other nations, the aid of science has been called in to render more perfect the different methods of illumination, many of those entrusted with the fitting up and management of the light establishments in this country have been, in a great measure, ignorant of the nature of the instruments which are its very essence.

The manner in which the oil, wicks and tube-glasses are supplied, is explained in a letter from the Fifth Auditor. These articles are delivered by the contractors at the different light-houses, generally in the

month of June or July. Should the lighting apparatus require repairs at this time, they are made while the oil vessel is waiting, and are, consequently, done hastily and in a very imperfect manner.

Within the third district it was found that the winter oil last delivered had not been tested in any one establishment; and in case oil of bad quality has been furnished, the fact will not be discovered until the oil is required for immediate use. Such was the case, I was informed by the light-keeper at the Morgan's point light, in the winter of 1836-37. The report of the keeper of Block island light for the year 1837, also shows that the oil consumed there throughout the last quarter of that year was of the second quality; and in the report of the keeper of Sands's point light for the same year, the oil is stated to be not of the first quality. By testing the oil immediately on delivery, and according to a certain standard, this difficulty would be removed, and justice done to both contracting parties.

The modifications required to render the present light establishment more effective, are suggested by the operation of the system under which it is organized. They have already been touched upon in the foregoing examination, and will now be briefly recapitulated.

1. More accurate information respecting the utility of a light appears to be required before its establishment is authorized. This will be obtained by the examination of the locality by persons possessed of the requisite hydrographical and nautical information, and by inquiring into the magnitude of the trade proposed to be benefited.

2. The exact site for the building should be determined on, upon examination by an engineer and seamen conjointly, in order that the position which will best show the danger to be avoided may be selected, and, at the same time, that a proper foundation for the building may be secured.

3. The appropriation should be based upon an estimate made after the plan of building suited to the locality, and the nature of the lighting apparatus, have been determined on.

4. The faithful construction of the light-houses, light-boats, and beacons, should be better provided for.

5. More knowledge and care are required in the construction, adjustment, and repairing of the lighting apparatus, and in adapting it to the different light stations; and provision should be made for the introduction of such improvements as may be, from time to time, suggested in the illuminating apparatus.

6. The inspection of the oil on delivery, so as to receive a supply of that article of the best quality, is of the highest importance. It may be proved by the oleometer, an instrument founded on the known difference in the specific gravity of sperm and whale oil, and which has already been adopted by one of the States as the standard for the purity of the former, and it may be subjected to trial by reduction of temperature and by burning.

7. A more vigorous superintendence, and more rigid inspection, are required; to obtain which, the number of district superintendents should be decreased, and appointments made with the especial view to that service. The keepers of the light-houses should be made acquainted with the nature of the apparatus they have in charge, and be instructed in the best manner of preserving it in good condition.

8. A more uniform system of buoyage is required, and its benefits should be equally extended over the navigable waters of the Union.

In order to obtain these requisites, I would most respectfully recommend that, in addition to the present head of the light establishment, the offices of inspector, engineer, and optician be created :

That the office of inspector be filled by an officer selected from the naval service, whose duty it shall become to examine the localities proposed for new lights ; to select the sites for light-houses, in conjunction with the engineer ; to determine on the positions in which to place the light-boats ; and to inspect, periodically, the light-houses, light-boats, and buoys :

That the office of engineer be filled by an officer of the corps of engineers, whose duty it shall be to examine and select the sites for proposed buildings, in conjunction with the inspector ; to form plans and make estimates for buildings, and supervise their construction and repair :

That the light-boats should be constructed of the most approved models, and of the best materials, at the different navy-yards, and delivered to the light department when in readiness to be placed upon their stations :

That the office of optician be filled by an individual possessing suitable attainments, whose province it shall be to decide upon the apparatus proper for each station ; and who shall superintend the making of the lamps, reflectors, and such other instruments as may be required in his department, and make periodical examinations of the different light establishments.

I would also respectfully recommend that a depot for oil and other supplies for the lights, and for the materials for buoys, be established in each of the present districts on the coast ; and that an officer be detailed from the naval service, to whom the immediate superintendence of each district shall be confided : that it shall be the duty of each district superintendent to make himself acquainted with the navigation of his district, and ascertain the facilities it requires ; to visit, frequently, the different light stations, and ascertain that they are in good order and properly kept ; also, to inspect the oil and other supplies on delivery, and distribute them as required at the lights, and superintend the buoyage of his district ; and that for these purposes a small vessel be provided and placed under his control : and that all the above-mentioned officers be under the direction of the head of the light establishment, to whom all reports shall be made, and whose duty it shall be, as at present, to make the necessary contracts, and exercise a general supervision.

All of which is respectfully submitted.

Your most obedient servant,

GEORGE M. BACHE,
Lieut. U. S. Navy.

Hon. LEVI WOODBURY,
Secretary of the Treasury.

EXTRACTS FROM SENATE DOCUMENT NO. 474, 26TH CONGRESS, 1ST SESSION,
(MAY 18, 1840.)

Mr. DAVIS made the following report :

The Committee on Commerce has examined the several communications of Mr. Lepaute to Mr. Davis, and beg leave to submit the following report :

In 1838 this committee made a report recommending the importation and trial of lenticular lights from France, believing the experiments which had been tried in the light-houses of that nation had fully established their superiority over reflectors. Pursuant to this recommendation, Congress passed a law authorizing the importation of two sets of apparatus, which, after great delays, have arrived at New York, but have not yet been set up. This apparatus has been constructed under the supervising care of a gentleman most favorably known in Europe as the superintendent of the construction of lenticular light-houses in France, Mr. Henry Lepaute. Being made acquainted with our desire to make a fair trial of this apparatus, through Captain Perry, of the United States navy, who was instructed to contract for two sets, he, in the most obliging manner, tendered his valuable services to see that the work was done in the most approved manner. One set is for a fixed light of the second order, and will, it is understood, be set up shortly at Sandy Hook, upon the great track of vessels entering and departing from New York, where its merits will be brought under the observation of shipmasters and mariners, standing, as it will, in direct contrast with the lights upon Navesink. This position will, therefore, be favorable in all respects for a trial, except, it is feared, the tower is not sufficiently elevated above the sea to give its greatest range to such a light. The other is a revolving light of the first order, and the Isle of Shoals, near Portsmouth, New Hampshire, has been thought of as a suitable place for it; but the height of the tower is inadequate to display the light in the most useful manner. This site is recommended, because it lays in the track of a great commerce, and in a region subject to that weather and fogs which will bring the power of the light to the severest test. All these matters are, however, confided to the care of the Fifth Auditor, Mr. Pleasonton, who appears to take a commendable interest in them, and feels anxious that the lights should be fitted up in the best manner, and a fair and full trial of them be made, and the committee have no fears as to the result.

If well authenticated evidence may be relied on, the brilliancy of the beam of light formed by the lenses has never been surpassed in light-houses, and we are deeply indebted to the learning and perseverance of those able, scientific gentlemen in France, who have devoted themselves with zeal and signal success to the improvement of light-houses.

Mr. Lepaute, who has given us many proofs of the value of his services in this department, asserts the extraordinary fact, that the first class of lenticular lights may be seen, with the naked eye, fifty miles; the second forty miles; the third twenty-eight miles; the third *small* twenty-five miles; the fourth revolving twenty miles; the fourth fixed fifteen miles; while it appears that none of ours are visible more than twenty-seven or twenty-eight miles, and most of them from ten to sixteen miles only. Therefore, the third order, and even the third small, is equal to our best; and the quantity

of oil consumed, Mr. Lepaute represents to be at least one-third less. It will be seen by the annexed table, that he has computed in kilogrammes, the quantity of oil consumed by each of our light-houses in a year, the aggregate of which is equal to 242,054, and also the quantity necessary for lenticular lights of equal power, which is equal to 130,300 kilogrammes. This presents to us a strong motive to persevere in the trial till we have seen for ourselves the results.

If they turn out as favorably as we have good reason to believe, we shall soon lay aside our reflectors for lenses, and probably diminish the number of our establishments considerably; our outer or sea lights, which are first seen by mariners approaching to the coast, ought mostly to be of the first and second order to give early warning to vessels. Those which are employed to indicate the channels and head-lands of our inland waters may be chiefly of the smallest order.

It is understood that Mr. Pleasonton has engaged an experienced artist to come over from France and set up the imported apparatus, which the committee consider a very judicious step, as this work requires skill and experience, and it is also essential that some one should be capable of instructing the keepers in their duties. Mr. Greenough has offered to fit the lamps for his chemical oil, and to try the experiment with it. This oil has been subjected to test in the light house at Boston, and burns with an intense brilliancy greatly surpassing sperm oil. It is desirable to see these improvements united, as the happiest results may be anticipated.

Several of our enlightened citizens have turned their attention with much zeal to the improvement of our light-houses. Of these Captain Perry, of the United States, was employed to contract for the several sets of apparatus imported by order of Congress; and while abroad, it is understood, collected much valuable information. The committee have on their files, translations of several French documents, communicated to them by Messrs. Blunt, of New York, which, so far as they are not similar to those before in their possession, they shall annex to this report. These gentlemen have devoted much of their time to this subject, and have collected much valuable information, which they have at all times freely communicated for the benefit of the United States.

The committee take much pleasure in laying before the public the subjoined papers from the pen of Mr. Lepaute, believing that they will add to the stock of general information, and draw the attention of the learned to this important subject. Our system has not kept pace with the improvement of the age, for we have, for a long time, made little advancement, while France and England have given an efficiency to their lights never before equalled. Having a great mercantile marine, and a great extent of coast, it is our interest, as well as our duty, to light, in the best manner, the dangerous path of the mariner; and the committee take pleasure in giving encouragement to every useful improvement designed for that end.

[TRANSLATION.]

Henry Lepaute, general superintendent of the construction of lenticular light-houses in France, residing in Paris, Rue St. Honore, No. 247.

SIR: Pray excuse the liberty which I take in addressing to you, enclosed, a comparative table of the annual expense of oil for the light-houses of the

United States, compared with a like number of lenticular light-houses of a corresponding brilliancy and *portée*, or reach.

The important report which you made on the 22d March, 1838, at the 2d session of the 25th Congress (which Captain Perry did me the honor to communicate to me,) on lenticular light-houses, demonstrates the interest taken by you in a system which presents such great advantages, not only in an economical point of view, which might be considered secondary in so important a service, but in the much more essential one of having good lights—considerations which you have pointed out in a manner so clear and precise, in demonstrating the advantages which navigators might derive from them.

The table which I have the honor to submit to you comprises two principal divisions, placed opposite to each other; the first, for *light-houses with reflectors*; the second, for *lenticular light-houses*.

The first division indicates, beside the name and character of the lights, the distance at which they can be seen, the number of burners which light these light-houses, and the annual consumption of oil in *kilogrammes*.

The second division indicates the character of those light-houses, generally similar to that of light-houses with reflectors, their degree of distance, in English marine miles, at which they can be seen, the order to which they belong, and the annual consumption of oil for each of them.

The work published this year by Mr. Coulier, entitled "A general description of light-houses," comprises a greater number of them than that comprised in the comparative table; but the names by which some are designated, not being the same as in your report, I have not been able to complete my work, for fear of giving to some light-houses a character different from that which they really have.

Notwithstanding that, I have, I fear, committed some errors on this subject; but I hope they will be few.

I have found more positive information, which alone has permitted me to complete this comparative table, in your above-mentioned report of the 22d of March, 1838, concerning the number of burners which illumine each light-house.

I have supposed that each of these burners was an Argand lamp, consuming 35 grammes of oil per hour, or 140 kilogrammes per year, and at 4,000 hours by night, the time during which the light-houses are lighted.

The lenticular light-houses are designated by their numbers of order, as first, second, third and fourth order. The light-houses of the third order are divided into two series; the first is on a large scale, and the second on the small scale, as indicated in the table by the sign *3p* (small model.)

Permit me, sir, to present to you some observations relative to the two lenticular apparatus of the first and second order, which I have executed on account of your government, and which were sent to New York in the month of August last.

I have added, also, some drawings, and some very detailed notes on the manner of arranging the apparatus for lighting, and particular instructions about the management of mechanical lamps, which are used in their illumination.

My information relative to arranging the apparatus for lighting, leaves me no grounds for uneasiness with regard to this work; but it is not the same with lighting and the care of lamps, although the instructions given for this object embrace all the details of their management, and makes cer-

tain provision against every accident which may occur; a practical instruction would have been one guarantee the more.

I proposed to Captain Perry to send, during eight or ten days, either into my manufactories, or into one of the lenticular light-houses near Havre, such as Barfleur or Fécamp, one of the mates or sailors of the ship in which the apparatus for lighting was to be embarked, in order to be transported to New York. This precaution, though not very expensive, would have been a good guarantee of a good method of lighting, without which a light-house cannot give all the light of which it is susceptible.

The position of the burner of the lamp in the apparatus for lighting, is what is most important to be observed. For the light-house of the first order, the upper part of the burner should be twenty-eight millimetres (a millimetre being the thousandth part of a metre,) *below* the middle of the centre of the large lenses. And for that of the second order, the upper part of the burner should be twenty-six millimetres *below* the middle of the central lens.

In order that the lenses may produce all the light of which they are susceptible, the flame should be twelve centimetres (a centimetre is the hundredth part of a metre) high for the first order, and ten centimetres for the second.

In order to ascertain whether a lamp is in full effect, an ordinary Argand lamp being taken as the unit, the distances at which the same degree of shadow is produced by both, upon a screen, is observed, and the result of calculations made on these observations, gives, as the measure of intensity of the lamp of the first order, twenty-five times that of the Argand lamp, taken as the unit, and fifteen times for the lamp of the second order.

You will doubtless see, sir, that I confine myself to details of little importance; but I beg you to believe that they are indispensable in order to obtain, from apparatus for lighting, those brilliant flashes which are the objects of admiration to the mariners who frequent our ports.

If I had not seen, by your report to Congress, the great interest which you take in the lenticular system, I would not have permitted myself to enter into the practical part of this service.

I have the honor to be, with the most distinguished consideration, sir, your humble and very obedient servant,

HENRY LEPAUTE.

Mr. DAVIS,

Member of Congress of the United States.

EXTRACTS FROM DOC. NO. 183, H. OF REPS., 27TH CONGRESS, THIRD SESSION.
FEBRUARY 25, 1843.

Letter from the Secretary of the Treasury, transmitting a report from I. W. P. Lewis, civil engineer, upon the condition of the light-houses, beacons, buoys, and navigation, upon the coasts of Maine, New Hampshire, and Massachusetts.

TREASURY DEPARTMENT, February 24, 1843.

SIR: I have the honor to transmit, herewith, in compliance with the resolution of the House of Representatives of the 23d of December last, the report of I. W. P. Lewis, civil engineer, on the examination of the light-house establishment of the United States so far as it has progressed, and which comprehends the description of seventy establishments in the

States of Maine, New Hampshire, and Massachusetts, being one-third of all the lights on the seaboard, and also the correspondence relative to this examination.

The light-house establishment having become a prominent branch of expenditure committed to the supervision of this department, my attention was arrested by an examination of the annual cost of maintenance, and the very large increase of expenditure devoted to this object for several years past. Believing that there must be some defect in the system of building, and that the large sums annually required for repairs pointed to such a cause, it was deemed proper to institute a special survey and examination, for the future guidance of this department.

The points on which the department required information are expressed in the letter of instructions to Mr. Lewis, to which the attention of the House is respectfully requested.

Impressed with the value of our light-house establishment, in its intimate connexion with the safety and security of commerce, and of the revenues dependent thereon, and believing that a greater degree of system in its details, and economy in its administration, are demanded by the public interests, I have to submit to the consideration of Congress the following suggestions, with the fullest confidence in their importance and necessity.

1st. That no appropriation shall be made hereafter for the erection of a new light-house, until the necessity of such a light shall have been ascertained by a competent engineer, who shall report to the Secretary of the Treasury the necessity of establishing the light petitioned for, the proper site to be selected, and a suitable plan, estimate and specification of the required buildings; also detailing the magnitude of the light required, and its distinctive character, with a view to render it intelligible to seamen, if established—all of which shall be submitted to Congress for such action as may be then deemed proper.

2d. Whenever the repairs of light-house buildings or floating lights called for exceed in amount five hundred dollars, the nature and extent of such repairs, and the probable cost thereof, shall be carefully estimated and reported to the Secretary of the Treasury by said engineer before they shall be authorized. All expenditures under the sum of five hundred dollars shall be made as heretofore. Contracts shall be made where the expenditure for the construction or repairs of land and floating lights exceed the sum of five hundred dollars, which contracts shall be subject to the approval of the Secretary of the Treasury, and be filed in the office of the First Comptroller of the Treasury.

3d. The system of illumination, and whatever is connected with the lighting apparatus, shall be placed under the supervision of the said engineer, who shall in all cases report to the Secretary of the Treasury the alterations or improvements, if any, which may be required. Such report to be approved before any alterations or improvements shall be authorized.

To the attainment of these purposes, it is proper that the Secretary of the Treasury be empowered to select and appoint a competent scientific and practical engineer, whose whole time shall be devoted to the regulation of the details of the light-house system, as set forth, and who shall report to this department, at the commencement of every session of Congress, to be communicated by the Secretary of the Treasury to Congress, the actual condition of the light-house establishment, its wants for the coming year, with detailed estimates, and such other information as comes within the

scope of his duties—the salary of said engineer to be not less than three thousand dollars per annum.

It may be proper here to remark that, on referring to prior acts of Congress appropriating moneys for a scientific examination of the light-house establishment, it will appear that, under the second section of the act of the 3d of March, 1837, (Laws U. S., vol. 9, p. 653,) entitled “An act making appropriations for building light-houses, light-boats, beacon-lights, buoys, and dolphins, for the year 1837,” before any of the improvements in said act were to be commenced, the board of navy commissioners were to cause an examination to be made, for the purpose of ascertaining whether the safety of navigation required any additional facilities, and to report to the Secretary of the Treasury, who would proceed with such improvements as they should report as necessary.

In the Treasury estimate for the year 1838, for the support of the light-house establishment, the following item was for the first time inserted:—“For expenses of a board of navy officers in examining and reporting the condition of all the light-houses annually, in addition to examinations already provided for, four thousand dollars.” The amount of the estimate for the light-house establishment for that year was \$356,863, and that sum was appropriated in the usual form of such appropriations, and including said four thousand dollars, as follows: “For the support and maintenance of light-houses, floating lights, beacons, buoys, and stakages, including the purchase of lamps, oil, keepers’ salaries, repairs, improvements, and contingent expenses, \$356,863.”

Subsequent estimates have included in the items for the support of the light-house establishment the sum of \$4,000, which has been inserted in those estimates in these words, viz: “For expense of examining and reporting the condition of all the light-houses, \$4,000.” And although this duty was no longer assigned to naval officers, no reason has been discovered for the discontinuance of this annual examination by scientific agents selected for the purpose. In regard to the authority under which this examination was instituted, I have to refer to the acts of Congress above cited, and to the opinion of the Attorney General herewith transmitted, which was obtained in consequence of the powers of the Secretary of the Treasury to institute such survey having been questioned shortly after the appointment of Mr. Lewis.

Accompanying this report will be found testimonials as to the qualifications of Mr. Lewis, and his fitness for the service to which he was appointed. It will be for Congress to decide whether the report itself does not justify the confidence which has been reposed in him.

The payments for the expenses of this survey have been made out of the following appropriation: “For examining and reporting the condition of all light-houses, annually, \$4,000,” as is shown by the letter of the Comptroller of the Treasury, herewith transmitted, dated the 17th January last. The expense of said survey has been \$3,672 60½ cents, which includes the sum of \$462 08, paid on account of the vessel employed in the survey.

The value of the information already obtained in the examination made by Mr. Lewis leads to the belief that the public advantage and the interests of commerce will be materially subserved by its continuance.

In the expenditure of the large sum now annually required for the maintenance of this establishment, so widely spread along the seacoasts and lakes of the United States, unaided by the science and skill now sought to

be obtained and secured, it has been found impossible to guard against all abuses. These necessarily result from the existing defects in the system, and must not be readily imputed to mismanagement of the department; and it is believed, if the necessary provisions be made by law for the improvements now suggested, the light-house establishment of the United States will be made much more efficient, and with every probability of a diminution of the cost of its annual support and maintenance.

All which is respectfully submitted.

W. FORWARD,
Secretary of the Treasury.

Hon. JOHN WHITE,
Speaker of the House of Representatives.

Extracts from the report.

* * * * *

As a rule of universal application to the light-houses of this coast, resulting from careful observation in clear weather, it may be stated that the towers can be seen further by day than can the lights they respectively bear by night.

In the structure of the lanterns and fitting up of the illuminating apparatus, all established rules and principles governing the subject are set at defiance, as the notes of survey will prove to every impartial mind.

* * * * *

The liberal appropriations made by Congress to multiply the number of light-houses, beacons, and buoys, and thereby increase the facilities of navigation on this coast, have been too often misapplied by those entrusted with the expenditures, and local interests are subserved, while the public still remain sufferers. It is very well for those who are totally ignorant of navigation in its simplest form, those whose limit of experience is not beyond the scope of a steamboat cruise in smooth water, to declaim about the superior character, economy, and efficiency, of our light-house establishment. Those practically acquainted with its defects, those who have felt the horrors of shipwreck, or know by sad experience the difficulties and dangers of navigation, even under the most favorable circumstances, seem to be of opinion that our light-house establishment is susceptible of some improvement, and that beacons and buoys may be multiplied to the immediate benefit and advantage of commerce. The mere arrangement of distinguishing lights on the coast of Maine will prove that there is neither knowledge of the wants of navigation, nor any attempt made to ascertain those wants.

It will be seen that the recurrence of distinctive lights must necessarily be rare, as there are only four in number that can properly claim that rank, and the intervening coast has lights precisely similar to each other. From Monhegan island seven fixed lights are visible at one view.

* * * * *

The numerous alterations required to obtain the distinctive lights set forth in the annexed schedule will of course be met with the usual and very proper objection, that the alteration of the character of a light, at any time, must always be attended with danger to those navigators who have not been duly

informed of the change. Formidable and true as this objection really is, yet it is not by any means insuperable. The whole of the great coast lights of France have been thus altered and essentially improved within a few years past, according to the plan of distinction and classification reported in 1825 by Admiral Rossel. Lights have been heretofore altered on our coast without any warning whatever to the maritime public, other than publishing the fact when such alteration was actually effected. The light-house at Mobile was altered from a fixed to a revolving one, and this, too, without the knowledge of the Fifth Auditor, and upon the sole responsibility of the contractor. The next light east of it, and about forty miles distant, being a revolving light, the similarity of appearance, and the absence of any warning whatever, produced several serious mistakes. (See Doc. 138, 25th Cong., 2d sess., pp. 6, 8.) When the two lights at Navesink were altered, and the lenticular apparatus put in operation, no notice was given to the public describing the characteristic appearance of these lights, so different from all others on our coast. Lights are extinguished for repairs at two days' notice, a recent instance of which occurred at Newburyport, and, when first relighted, the lamps and reflectors were faced towards the town for the amusement and gratification of the inhabitants. No coast light should be altered without six months' notice, published in all the leading journals of the day, and information further extended by means of handbills to be issued at all the custom-houses. The same rule applies quite as forcibly to the establishment of any new light-house, beacon, buoy, or floating light. Such a wholesome regulation is, however, unknown to the light-house service of this country; while in Great Britain, France, and all European maritime nations, it is most strictly observed, not only in stating the fact simply, but also every particular connected with it, such as the color, times of revolution, or other characteristics of the light, with its compass bearings from all prominent objects in that vicinity, its limit of visibility, its particular uses to the local navigation, &c.; and the same formula is observed in respect to beacons, buoys, and floating-lights. Hardly a month passes, that we do not see one or more of these notices of foreign lights, &c., republished in our newspapers by official agents resident in this country.

* * * * *

But we must avail ourselves of the improvements adopted for many years past in Europe, and which have not only stood the test of long experience without fault, but raised the character of the French lights above all others. An examination of Doc. No. 274, 27th Congress, 2d session, will satisfy every one of the nature of the French system, and the great care that is taken to ensure the faithful performance of the contracts. It is proved by this document that the entire light-house establishment of France, embracing the channel, ocean, and Mediterranean coasts, and illuminated by 119 light-houses arranged in four distinct classes according to their local importance, is maintained at an annual expense of 355,446.45 francs, which, allowing 19 cents to the franc, is but \$67,534 77. This is an official document, emanating from the chief engineer of the light-house administration, and the translation of it transmitted to Congress by the Fifth Auditor, who complains that the item of repairs (which he admits constitutes "one-half of the expense of our establishment") is entirely omitted. By reference to the document, it will be seen that this statement of the Fifth Auditor is erroneous. On page 3 will be found a schedule, forming the basis of the contracts, and articles 3, 4, 5, 6, 7 and 8 apply exclusively to repairs,

and the succeeding pages give the details of repairs required at the expense of the contractor. The reason that the repairs of French light-houses form so small an item is, that they are designed by and constructed under the direction of architects and engineers whose education fits them for the execution of such works. If the French Government entrusted the construction of their light-houses to contractors, as has for many years past been the case in this country, it is more than probable the item of repairs would exceed the entire sum paid now for complete maintenance.

The radical cause of the present defective condition of our light-house establishment seems to be found in the law of 1789, which provides for the erection and construction of all light-houses beacons and buoys by contract with the lowest bidder whose qualifications or responsibilities are unquestioned, "provided he can give bonds for the execution of the work." But the same law (and it is the only one bearing upon the subject) omits to provide for the examination of the site, or the preparation of a design of construction suited to such site whatever may be its peculiarities. It omits, in short, every wholesome regulation calculated to confine the cupidity of contractors within the bounds of honesty; and the nation has thus been encumbered with a family of 250 light-houses, all more or less defective, and all crying out for continual repairs.

As parabolic reflectors are known to give the most intense effect when the burners are perfectly adjusted to the focal point, so it was taken for granted, on this examination, that the persons employed to fit up the light-houses with the illuminating apparatus would attend most carefully to the practice of this rule. The necessity also of having each reflector secured with its axis truly horizontal, it was also supposed would be particularly noticed. But, in every instance, these important elements were omitted; and, in fact, the arrangement, design and construction of the entire apparatus is such as to render these adjustments impossible; consequently, the burners were never found in any one series uniform in position, the variation amounting to more than one inch, and the reflectors out of the perpendicular from a half inch to two inches. It is evident that, if the reflector does not stand truly vertical, its axis will be either depressed or elevated, and the light from it fall upon the earth or ascend to the stars, without being visible to the navigator.

The arrangement of the lamps on circular horizontal planes in all the fixed lights, without regard to peculiarity of location or the evident wants of navigation, is one among the most prominent errors of the present system, common to all the fixed lights in the United States; and the large number of lamps required by this plan to illuminate a given portion of the sea horizon will appear evident, when it is seen that each reflector can only cover a certain space in the direction of its axis, and in no other. Thus, in narrow channels or straits, rivers, and estuaries, where light is only required in one or at most two directions, we have it in eight or ten directions, three-fourths or four-fifths of the oil burning to no purpose whatever.

The lanterns containing the lamps and reflectors are by far the most curious part of the light-house establishment. They are all of one uniform model, differing only in magnitude—octagonal on the plan, the height of the sides being about equal to the diameter at the angles. The frames are very ponderous, of wrought-iron, and containing, by a fair estimate, three times the quantity of material requisite. The angle posts are two inches square, and, with the sashes attached, the width of the angles

is increased to four inches; the sash bars are one inch wide; and the glass mostly ten by twelve inches (excepting a few fitted up quite recently, which were copied from the improvements made at Boston light,) and of the most impure kind, full of striæ and veins, so that what light escapes from its iron cage is refracted in all directions by the effect of the glass, and but a small portion reaches the eye of the observer.

KEEPERS.

One of the most important steps, after establishing a light-house, is the selection of a suitable keeper, for upon him depends, in a great measure, the efficiency and steadiness of the light under his care; the more so, as but one keeper is allowed to each establishment on our coast, excepting in the case of a few southern lights. Thus it becomes necessary for these functionaries to leave their beds at night to examine and trim their lamps—a sacrifice of personal comfort which few of them are willing to make. The usual routine of their practice consists in lighting up at twilight, and then trimming between eleven and twelve at night; after which, the lamps burn or not, as the case may be. It is therefore no uncommon occurrence to see a light gradually disappear between three and four o'clock in the morning. The best keepers are found to be old sailors, who are accustomed to watch at night, who are more likely to turn out in a driving snow storm and find their way to the light-house to trim their lamps, because in such weather they know by experience the value of a light; while on similar occasions the landsman keeper would be apt to consider such weather as the best excuse for remaining snug in bed. One of the greatest disadvantages attendant upon the obtainment of good keepers is the rate of salary allowed, which, in this country, will not command the services of intelligent men, such as are required to do justice to a valuable and costly apparatus, when such is entrusted to them.

BUOYS.

Every gale of wind and every field of floating ice carries off a greater or less number of these buoys, and considerable time must elapse before they can be replaced. If they were suitably moored, such losses would rarely occur. The use of *screw moorings* are yet unknown in this country, while England has availed herself of this valuable invention, and not only retains her buoys and floating-lights at their stations, but also as a means of founding light-houses and beacons upon shoals hitherto considered inaccessible to the engineer.

These moorings involve a greater expenditure at the outset, which is fully compensated for by their immovability. The systematic coloring and marking of buoys on the British coast, together with the official and descriptive catalogues published and issued at the various seaports for the information of seamen, is a feature of administration that might be copied with advantage to the commerce of this country.

NEW YORK, *June 2, 1842.*

The subscribers, captains of packet ships and other vessels engaged in commerce from the port of New York, beg leave respectfully to represent:

That it is a matter of the greatest importance to us as seamen, and also to the mercantile community, that the light-houses, beacons, buoys, &c., on our own as well as on foreign coasts, should be as perfect as possible, and kept in the best and most efficient manner. That the subscribers deem themselves fully competent to judge of and form comparisons between the light-houses of France and Great Britain, and other European maritime nations, and the light-houses on our own coasts; and they assert, without fear of contradiction from those who have the power of comparing, that the light-houses of France and Great Britain, in brilliancy and efficiency, are far superior, with one exception, to any on our own coasts; that they can be seen at much greater distances, and, from their superior brilliancy, cannot be taken for a star or a vessel; and are well arranged, so as to be easily discriminated.

The exception alluded to above is in the two new lights at the entrance of the harbor of New York, altered, within two years, to lights of the best kind.

The subscribers also represent, that within the last fifteen years great improvements have been made in light-houses in France and Great Britain, and other maritime nations; that on the coasts of these two nations the lights have been arranged in a regular system, with regard to the class, of harbors, &c., while our own light-houses have remained without substantial improvement; that alterations, without notice to mariners, have been made frequently on our coasts, and great losses thereby incurred.

The subscribers, in conclusion, respectfully represent, that our light-house system requires a thorough examination by competent and disinterested persons; that on such examination we believe it will be found greatly deficient. They therefore respectfully request that such thorough examination may be made, preparatory to a general improvement and approximation to the light-houses of the great maritime nations of Europe.

J. C. Delano, ship Patrick Henry.	E. Hammond, ship Hilah.
E. Crabtree, ship Hottinguer.	John Story, ship Talbot.
A. Burrows, ship Geo. Washington.	George Drew, ship Aldebaran.
F. H. Hebard, ship Quebec.	Z. D. Basset, jr., barque Z. D.
Caleb Anthony, jr., ship Argo.	W. C. Faulkner, brig Washington.
C. R. Griffith, brig Lawrence.	A. S. Wall, brig Vandalia.
J. S. Hayes, brig Moon.	Silvanus Prince, brig Star.
Alex. Britton, ship United States.	Edward Lermond, barque Ludwig.
Thomas Lyon, brig Clinton.	Matthew Kinney, brig Eliza.
George B. Bucknam, ship Solon.	John M. Coombs, brig Zealand.
Joseph Hamilton, brig Sterling.	John P. Nichols, brig Grand Turk.
Charles H. Coffin, ship Harbinger.	Barnabas Sherman, brig Adna.
Edward Rosseter.	Simon H. Good, brig Tom Paine.
W. H. Russell, ship Saratoga.	J. I. Stevens, barque Nancy W. Ste-
Oliver P. Brown, ship St. Lawrence.	vens.
Richard Adams, brig Casper Hauser.	J. Silvester, ship Henry Thompson.
B. Smith, ship Cristoval Colon.	D. C. Coupland, barque Ellen.

W. D. Coulthard, barque Elizabeth, Glasgow.	D. K. Brannon, Noodus.
Thomas Hiller, brig Montevideo.	James N. Knapp, barque Oberlin.
J. B. Bedell, brig Saratoga.	J. T. Safford, brig Jane.
C. K. Crocker, ship Splendid.	Oliver Eldridge, ship Gaston.
G. Walker, ship "Royal Sovereign."	Benjamin W. Bedell, brig Georgiana.
D. B. Barton, ship Norma.	W. T. Thompson, ship Q'n Victoria.
Richard H. Ellis, ship Hellespont.	John E. Schley, ship Globe.
Stephen Coulter, ship Georges.	John C. Thorp, ship Gen. Parkhill.
H. S. Maye, barque Everton.	John Madison, brig Fame.
Frederick Sherwood, brig Emily.	John A. Bradstreet, ship Gardiner.
John Wyle, ship Colossus.	W. B. Drew, barque Mary Chilton.
James Renne, ship Gondola.	Charles H. Marshall.
Daniel Hood, barque Hebron.	E. D. Hurlbut & Co.
Paul Townsend, brig Tray.	Grinnel Mistock.
W. C. Wyman, brig Creole.	Rt. Kermit.
A. Blivon, brig Kentucky.	Andrew Foster & Sons.
D. Forbes, brig Motto.	Goodhue & Co.
S. Myers, brig Belle.	Howland & Aspinwall.
F. W. Barkmen, ship Anson.	James Hunck, packet ship Oneida.
B. B. Williams, late barque Clarion.	Joseph Tinkham.
Charles Bransom, brig Etrurian.	J. Evans.
E. & G. W. Blunt,	Spoffar, Tilerton, & Co.
David Jackson, ship Ocoree.	A. G. L. & W. Benson.
C. Holton, Fox & Livingston.	Benjamin Richards.
	David Hepburn, ship Niantic.

The undersigned believes an examination to be necessary.

ZEB. COOK, Jr.,

President Mutual Safety Insurance Company.

I concur in the propriety of an examination of the light-houses on our coast.

WAITER R. JONES,

President Atlantic Mutual Insurance Company.

The Atlantic Insurance Company of New York, by

J. L. HALE, *President.*

The American Insurance Company in New York, by

JNO. C. DELPRAT.

The Jackson Marine Insurance Company of the city of New York, by

S. BALDWIN, *President.*

The General Mutual Insurance Company, by

ABR. OGDEN, *President.*

The Sun Mutual Insurance Company, by

ALFRED SETON, *President.*

The New York Insurance Company, by

B. W. EVUS, *President.*

Washington Marine Insurance Company, by

JACOB HARVEY, *President.*

Hon. WALTER FORWARD,

Secretary of the Treasury.

Boston, June, 1842.

SIR: We are informed that you have appointed our fellow-citizen, Mr. I. W. P. Lewis, to make an examination of the entire light-house establishment of the United States, and from the information he will thus obtain to report to you a plan for remodelling the present system, with a view to render it as fully effective to the interests of commerce and navigation as the advanced state of scientific knowledge in light-house illumination will allow.

We beg leave to express to you our hearty concurrence in this measure, believing as we do that it is one calculated to produce results of the highest importance, and absolutely necessary to the interest of our great and increasing maritime community.

J. INGERSOLL BOWDITCH,

President American Insurance Company in Boston.

JOSEPH BALCH,

President of Merchants' Insurance Company in Boston.

FRANCIS WELCH,

President of the Franklin Insurance Company of Boston.

ROBERT FARLEY,

Secretary of the Atlantic Insurance Company.

ROBERT B. WILLIAMS,

President of the United States Insurance Company.

NATHANIEL MERIAM,

President Mercantile Marine Insurance Company.

LEMUEL POPE,

President Boston Insurance Company.

C. W. CARTWRIGHT,

President Manufacturers' Insurance Company.

JOHN G. NAZRO,

President Tremont Insurance Company.

PELHAM W. HAYWARD,

President Suffolk Insurance Company.

THOMAS LAMB,

President Washington Insurance Company.

C. CURTIS,

President of the Neptune Insurance Company.

SAMUEL W. SWEET,

President of the National Insurance Company.

JOHN CLARK,

President Equitable Safety Insurance Company.

JOS. H. ADAMS,

President N. E. Mutual Marine Insurance Company.

JOHN S. DIMMOCK,

President Warren Insurance Company.

THOMAS B. WALES.

JOSIAH BRADLEE & CO.

NATHANIEL H. EMMONS.

HENRY HALL.

EBEN CHADWICK.

DANIEL P. PARKER.

BENJAMIN RICH.

JOHN S. SLEEPER.

Hon. WALTER FORWARD,

Secretary of the Treasury.

Questions proposed to Lieutenant George S. Blake, U. S. Navy.

Question. Are you acquainted with the mode of buoyage now used in the United States?

Answer. I am acquainted with the system of buoyage so far as it has fallen under my observation since my employment on the Coast Survey, viz: through Long Island and Fisher's Island sound, and the Delaware river and bay.

Q. Do you consider the present system of buoyage as fulfilling all the requisite conditions to safe navigation?

A. I do not.

Q. Are the buoys that you have noticed so placed as to mark the position of the shoals or dangers in the best manner?

A. In some instances they are; and in others they are so placed as, in my opinion, to lead vessels into danger, instead of guarding them against it.

Q. Do you consider the present manner of mooring buoys as sufficient to prevent their loss or change of position?

A. I frequently have seen buoys very much out of position, and have therefore been led to believe that they were not sufficiently moored in the first place.

Q. Have you noticed whether buoys are so formed, marked, or otherwise distinguished as to be known by such peculiarity?

A. With very few exceptions, I have not been aware of any such distinguishing marks upon buoys.

Q. Do you think a system of buoyage could be devised by which the navigator could be able to determine his own position with respect to that of any shoal or other obstruction?

A. I do.

Q. Are you familiar with the site of the Romer beacon? and, if so, please state whether, in your opinion, it occupies the best position for the guidance of vessels entering the bay of New York.

A. I am unacquainted with the site of the Romer beacon.

GEORGE S. BLAKE,
Lieutenant U. S. Navy.

DISTRICT OF COLUMBIA, }
Washington county, } ss.

On this 29th day of April, in the year of our Lord eighteen hundred and forty-two, before me, the subscriber, a justice of the peace in and for said county, personally appeared Lieutenant George S. Blake, U. S. Navy, and made oath, in due form, that the above answers are true; and further he saith not.

GILBERT L. GIBERSON, J. P.

OFFICE COAST SURVEY,
Capitol Hill, April 15, 1842.

SIR: I have the honor to transmit herewith my answer to the interrogatories relative to the lights of the Navesink, New Jersey, propounded to me by the commissioners of investigation, &c.

I am, sir, respectfully, your obedient servant,

GEORGE S. BLAKE.

Hon. GEORGE POINDEXTER, &c.

Answers of George S. Blake to interrogatories relative to light-houses.

I am a lieutenant in the navy of the United States, and have been employed for seven years past upon the survey of the coast.

I have seen the French lenticular lights upon the highlands of Navesink, New Jersey, repeatedly. It is my opinion that in point of brilliancy they are very far superior to the light at Cape Henlopen, or any other coast light of the United States that I have seen.

DISTRICT OF COLUMBIA, }
Washington county, } ss.

On this 15th day of April, in the year of our Lord eighteen hundred and forty-two, before me, the subscriber, justice of the peace in and for said county, personally appeared George S. Blake, and made oath, in due form of law, that the facts set forth in the above answers are true.

GILBERT L. GIBERSON, J. P.

Questions proposed to Commander Thomas R. Gedney, U. S. Navy.

1. Are you acquainted with the present system of buoyage in the United States?
2. Does it fulfil the conditions which a proper system should fulfil?
3. Are the buoys generally, as far as you have had occasion to notice them in your surveying duties, placed in the most advantageous position for marking the shoals?
4. Are the moorings sufficient to sustain the buoys in their places? and have you known any instance of their having been removed by mischievous persons?
5. Is there any distinction made in the color or shape of buoys by which the navigator may determine whether he is upon the deep water side of the buoys or not?
6. Are there any means at present in use by which the buoys could be discriminated; or can you suggest any which could enable one to say whether it marked the right or the left hand of the channel way?
7. Are you acquainted with the locality of the Romer beacon? If so, state whether in your opinion it is in the proper position or not.
8. Have you had any occasion to notice the manner in which the beacon-lights at Sandy Hook are kept?
9. Were they, at the period you refer to, properly kept? State the particulars.
10. Have you formed any opinion as to the comparative brilliancy of the lenticular lights lately set up at Navesink, and the light at Cape Henlopen since its refittal?
11. How does the fixed light at Navesink compare with Sandy Hook light in point of brilliancy?

WASHINGTON, *April 27, 1842.*

SIR: Having been charged by the Secretary of the Treasury with an examination into the subject of light-houses, beacons, and buoys, we have to request the favor of you to answer, under oath or affirmation, the interrogatories annexed, and to transmit to us your answer at your earliest convenience.

We are, sir, your most obedient servants,

GEORGE POINDEXTER.

W. A. BRADLEY.

Commander THOMAS R. GEDNEY.

WASHINGTON, D. C., *May 16, 1842.*

GENTLEMEN: In answer to your interrogatories of the 27th ultimo, I respectfully beg leave to state, that my official duties have required me to observe the system of buoyage as it now exists, and I am of opinion that great improvements might be made.

The buoys do not answer all the purposes intended, as I have known some of them to be put down from one-fourth to half a mile out of their proper positions; the moorings also are insufficient, and I have known some removed by vessels making fast to them, instead of coming to an anchor, and others by the anchors of vessels under way becoming foul and dragging them a considerable distance. From personal knowledge, I am unable to impute malicious motives to any one, but strongly suspect this to be one of the causes of their removal.

I am not acquainted with any general system adopted throughout the United States of marking buoys, by which the navigator can distinguish the deep water side of the channel, but, in other countries, difference in color or shape has been adopted for this purpose; and I would respectfully suggest either that the buoys on the right hand side of a channel, as you enter a harbor, should be painted black, and those on the left painted white, or that the distinction should be made by a difference in their shapes. If this system should be adopted throughout the Union, the navigator would instantly discover on which side of the channel he was, by the color or shape of the buoy. The present system I consider expensive, as well as inefficient, being extremely liable to be carried away by ice or other things floating with the current; and, as an instance, I have known a buoy, with moorings attached, removed by ice from Goat island, in Newport harbor, to have been picked up thirty miles outside Sandy Hook.

The economy and utility of Mitchell's improved screw-buoys having been fully tested in the English harbors, I would respectfully recommend their adoption in place of those now in use.

I am particularly well acquainted with the position of the "Romer beacon," and know it to be placed one and one-fourth mile northwest of the extreme point of the shoal—the position it should occupy—and well calculated to deceive a stranger entering the harbor of New York. I have been informed that several vessels have been lost in consequence of its present position, and would strongly recommend that a beacon be erected on the proper site.

While employed at Sandy Hook in 1835, I had on one occasion to send on shore as late as nine o'clock p. m., and request the keeper to light up

both light-house and beacons; and, on another occasion, to send on shore at eleven o'clock and request the beacons to be lighted, the man employed by the keeper having neglected his duty, and the keeper not giving it his personal attention. At that time, it was customary for the keeper to employ a man at one hundred dollars per annum to superintend the lights, and neglect himself to give them his supervision.

The lenticular lights at the Navesink so far surpass in brilliancy the lights at Cape Henlopen and Sandy Hook, as scarcely to admit of a comparison.

The lamps and reflectors at Cape Henlopen light-house I consider injudiciously arranged, as several of the lamps reflect only on the land side, and are, I believe, of little or no use.

Respectfully, your obedient servant,

THOMAS R. GEDNEY,
Commander U. S. Navy.

MESSRS. POINDEXTER and BRADLEY,
Commissioners, &c.

DISTRICT OF COLUMBIA, *Washington county, ss:*

On this 16th day of May, 1842, personally appeared before me, Thomas R. Gedney, who, being duly sworn, deposeth and saith that the foregoing are true answers to the annexed interrogatories propounded to him by Messrs. George Poindexter and W. A. Bradley.

THOMAS R. GEDNEY.

Sworn to and subscribed before me, the day and year above written.

ROBERT GETTY,
Justice of the Peace.

WASHINGTON, *April 26, 1842.*

GENTLEMEN: I return you the questions asked, with my answers, concerning the light-houses on the coast of the United States.

Respectfully, your obedient servant,

EDMUND BLUNT.

MESSRS. POINDEXTER and BRADLEY.

Queries to Edmund Blunt, Esq., United States coast survey office, with answers of Mr. Blunt.

Question. What is your residence and occupation?

Answer. I reside in Brooklyn, New York, and am at present employed as an assistant in the survey of the coast of the United States.

Question. Have you visited many of the coast lights of the United States? State what lights.

A. I have visited, at various times within the last twenty years, many of our light-houses, and state the names, with dates, to the best of my recollection, commencing with the most eastern.

Point Judith, Rhode Island, 1838.

Watch Hill, Rhode Island, 1837, 1838.

Montauk, New York, 1837, 1838, 1839.

Gull Island, New York, 1829.

Saybrook, Connecticut, 1829.

Faulkner's Island, Connecticut, 1829.

New Haven, Connecticut, 1829.

Plumb Island, New York, 1829 and 1836.

Stratford Point, Connecticut, 1829.

Oldfield Point, New York, 1829.

Black Rock, Connecticut, 1829.

Eaton's Neck light, New York, 1829, 1831, 1834, and 1836.

Sand's Point, New York, 1821, 1834, and 1836.

Throg's Neck, New York, 1829.

Fire Island light, New York, 1831, 1834, and 1835.

Sandy Hook, New Jersey, 1831 and 1835.

Staten Island, New York, 1831.

Princess Bay, New York, 1831.

Highland lights, New Jersey, 1831.

Cohansey light, New Jersey, 1841.

Egg Island light, New Jersey, 1840, 1841.

Bombay Hook, Delaware, 1840, 1841.

Mahoun's Ditch, Delaware, 1840.

Cape May, New Jersey, 1841.

Cape Henlopen, Delaware, 1841.

Q. What is your opinion as to the method of illumination, and what improvements can you suggest?

A. I consider the method of illumination to be bad, and would suggest such improvements as have been introduced in France and England within the last ten years. The account of these may be found in several of the documents printed by order of the United States Senate—particularly in 25th Congress, 2d session, 428; 26th Congress, 1st session, 474 and 619; and Document No. 190, House Representatives, 25th Congress, 3d session.

Q. What is the general condition and repair of the lights you have seen?

A. The *general* condition of the lights was bad at the dates mentioned. I do not recollect finding a lamp properly made or constructed. Many, however, were good of their kind, and *did not leak*; and most of the lanterns were so constructed and glazed as to obstruct or absorb nearly one-quarter of the horizontal rays from the lamps. Most of the buildings leaked.

The lights of Cape May and Cape Henlopen had been repaired and improved before I visited them, and, compared to our other lights, showed to advantage; but neither the lamps nor reflectors were calculated to exhibit the Argand lamp and parabolic reflector to advantage. I found also in those light-houses under charge of the collector of Wilmington, which I visited in 1841, repairs going on, creditable to him, the want of which had been long complained of.

Q. What do you know of the repairs that were made upon the lights at Montauk, Gull island, and Watch hill, in Long Island sound, subsequent to the date of your memorial to the 25th Congress?

A. I stated in 1837 that the lighting apparatus at Montauk and Watch hill was not good, (page 4, Senate Doc. 138, 25th Congress, 2d session.)

It was denied by Mr. Lewis's letter; and yet I found, on visiting them the next season, that this same Mr. Lewis had been sent to repair them. Since that period, several of the lights which he then stated could be seen far beyond what the figure of the earth would allow, (even at an elevation of fifty-five feet from the observer,) have been refitted.

Q. What is your opinion upon the economy and brilliancy of the British and French, as compared with the United States lights?

A. It is impossible to compare the two systems together, as to economy. In France and England all the light is economized, and science is brought to aid, while here it is rejected. A greater intensity could be produced in our lights, and nearly one-half the oil saved, should we introduce gradually the lenticular apparatus; but at the dates and places mentioned, the brilliancy would not compare with any light I have seen in England or France.

Q. Do you think that any of our floating lights could be replaced by permanent structures?

A. I do.

Q. Do you consider the present organization of the United States lighthouse system as well adapted to the wants of the country, or can you suggest any plan for its improvement, with your reasons for the same?

A. I do not consider the present organization good, or calculated for the wants of commerce. Little or no information useful to seamen can be obtained from the superintendent; and as he is only an accounting officer, he cannot be supposed to have the knowledge or time requisite to superintend so extensive an establishment. It should therefore be placed where there is a knowledge of engineering, surveying, hydrography, optics, and such other matters as would enable those having charge to decide if a lighthouse is required, where it could be located to advantage, the kind of light required, and the expenses of building; also, when built, to be able to inform the maritime world of its geographical position, and *the purpose for which it is built*. The reasons for recommending this are evident.

EDMUND BLUNT.

DISTRICT OF COLUMBIA, *Washington county, to wit:*

Subscribed and sworn on this sixteenth day of April, 1842.

CLEMENT T. COOTE, *J. P.*

Extracts from H. R. Doc. No. 811, second session 29th Congress, Mr. J. C. Clark, reporter, Committee of Commerce.

SUPERINTENDENTS AND KEEPERS, AND THEIR SALARIES—INSPECTORS.

Forty-four collectors act as superintendents of the lights in their respective districts. By the act of May 7, 1822, their maximum compensation per annum is \$400. Some four or five receive that amount; the others receive from \$100 to \$200 each, per annum. These superintendents are required to visit the light-houses but once in each year. Captain Howland, who is in the employ of the Department, also visits them once in each year, and makes reports of their condition, &c., to the Fifth Auditor.

In the opinion of the committee, there should be established a plan of inspection more efficient. Frequent visitations and minute examinations,

by competent inspectors, would insure vigilance, economy and order on the part of the keepers. The inspectors should be men thoroughly acquainted with all the details of light-house management and superintendency, with the manner of adjusting the lamps and reflectors, and of keeping them in good order.

Frequent reports from them to the general superintendent would enable the latter to judge of the faithfulness and ability of the keepers, of the amount of the necessary repairs, of the quality of the oil consumed, of the quality of the lights; in a word, with all the minutiae of the establishment.

The collectors, acting as superintendents, cannot possess that information and practical knowledge necessary to a perfect administration of the system. The mode of conducting it has formed no part of their studies. They lack both theory and experience.

In a report made to the Senate, from the Committee on Commerce, by Governor Davis, in 1838, (see Sen. Doc. vol. 5, 1837-'38, No. 428,) this subject is noticed. He says: "The lights should be visited by a general inspector, who is master of the whole subject, being fully capable of estimating the true character of the apparatus, its condition, the manner in which it is managed, whether the keepers are capable and faithful, and whether the oil is such as it should be. In short, this visiter should be so thoroughly skilled in everything pertaining to the subject, as to keep the light-houses in as perfect a condition as the arts and the progress of science will allow." Again: "We have already said certain collectors of the customs are the inspectors of the light-houses in their respective districts. It is manifest the two offices have no natural connexion; for they require qualifications quite different. The one should understand the laws of light, as it is affected by reflectors and refractors; the other, the character and the value of merchandise; and there is no affinity between the employments; nor does it follow that one who is well qualified for a collectorship has a particle of that information which is essential to a well-conducted system of lights." Again: "The number is great; the duty is merely collateral; their visits are seldom; their attention little engaged in the matter. They have no control over the system, have no knowledge beyond their districts; and the consequence is, that their inspection is generally of little importance, and has little tendency to expose the faults or improve the character of the system. Indeed, so necessary is some other inspection, that the contractors who furnish oil are required to view and report upon the condition of each light; and so also are the immediate keepers. The subject was early committed to the collectors, as a matter of convenience; but we may well inquire now whether its importance does not call for a more skilful supervision—one that can give harmony and character to the whole system, and make it not only keep pace with the progress of population and business, but with the advancement of mechanical and scientific improvements."

In the opinion of the committee, these views are entitled to the respectful consideration of Congress.

The appointment of inspectors, whose duty it should be to devote their entire time, under the direction of the general superintendent, to frequent examinations of the light-houses, light-boats, buoys, &c., would be attended with no great increase of expense. The amount now paid to the collectors acting as superintendents is about eleven thousand dollars. There is already attached to the establishment a small vessel. That, with the addition of another, and the salaries of two inspectors for the two districts

on the Atlantic coast, bays, &c., if two should be deemed necessary, the increase of expense will be inconsiderable. The frequent reports of these inspectors to the general superintendent would enable him at all times to know the precise condition and order of the establishment, and to increase its efficiency, usefulness and economy.

Light-houses fitted up with the improved parabolic reflectors, and cost of the same.

1839.	<i>Boston light-house.</i>		
	15 lamps and reflectors, procured in England in 1839, at £29 12s. 6d. each.		
	14 put in this light-house, cost £414 15s., par.....	\$1,843 33	
Dec. 31	Paid J. W. P. Lewis and H. N. Hooper, for a new lantern, and fitting up.....	2,905 83	
			\$4,749 16
	<i>Cape Cod light-house.</i>		
Sept. 30	Paid H. N. Hooper & Co., for 15 21-inch reflectors, 15 lamps, lantern, deck, chandelier, &c	\$4,056 87	
Dec. 31	Paid J. W. P. Lewis, for preparatory repairs and fitting up.....	1,863 03	
			5,919 40
	<i>Thatcher's Island (two) light-houses.</i>		
1841.			
June 30	Paid Winslow Lewis, for new lanterns and fitting up with 10 lamps and 10 21-inch reflectors each, (including preparatory repairs)		5,860 00
	<i>Scituate light-house.</i>		
June 30	Paid Winslow Lewis, for a new lantern and fitting up with 11 lamps and 11 14-inch reflectors, (including preparatory repairs)		1,910 00
	<i>Chatham (two) light-houses.</i>		
Sept. 30	Paid Winslow Lewis, for rebuilding these two lights, and fitting them up with new lanterns and 10 lamps, and 10 14-inch reflectors each.....		5,849 40
	<i>Faulkner's Island light-house.</i>		
1840.			
Sept. 30	Paid J. W. P. Lewis, for fitting up with new lantern and 9 lamps, 16-inch reflectors.....		2,842 41
	<i>Stonington light-house.</i>		
Sept. 30	Paid J. W. P. Lewis, for fitting up with new lantern and 8 lamps, and 8 16-inch reflectors		1,938 30
	<i>Newport light-house.</i>		
1841.			
Dec. 31	Paid Winslow Lewis, for fitting up with 15 lamps and 15 15-inch reflectors		750 00
	<i>Cape Henlopen light-house.</i>		
1840.			
June 30	Paid Winslow Lewis, for fitting up with new lantern and 18 lamps, and 18 21-inch reflectors.....		3,500 00

Light-houses—Continued.

<i>Cape Henry light-house.</i>		
1841.		
Dec. 31	Paid Winslow Lewis, for fitting up like the above, (including some repairs)	\$4,000 00
<i>Old Point Comfort light-house.</i>		
Dec. 31	Paid Winslow Lewis, for fitting up with new lantern and 11 lamps, and 11 14-inch reflectors	1,775 00
<i>New Point Comfort light-house.</i>		
Dec. 31	Paid Winslow Lewis, for fitting up with new lantern and 10 lamps, and 10 14-inch reflectors	1,900 00
<i>Charleston light-house.</i>		
1842.		
March 2	Winslow Lewis's offer accepted to fit up this light-house with a new lantern and 12 lamps, with 12 21-inch reflectors	3,500 00
<i>Tybee light-house.</i>		
1841.		
July 20	Winslow Lewis's offer accepted to fit up this light-house with a new lantern and 15 lamps, with 15 16-inch reflectors	3,500 00
<i>Tybee beacon light.</i>		
1840.		
Sept. 30	Paid J. W. P. Lewis, for fitting with new lantern, 8 lamps, and 8 16-inch reflectors	1,693 96
<i>Wolf Island (two) beacons.</i>		
1841.		
March 31	Paid Winslow Lewis, for rebuilding the wooden beacon, and fitting up both with new lanterns and 6 lamps, with 6 14-inch reflectors each	3,450 00
<i>Thunder Bay light-house.</i>		
Sept. 30	Paid Winslow Lewis, for fitting up with 11 lamps and 11 14-inch reflectors	600 00
	Add	52,732 68
<i>White Island light-house.</i>		
March 31	Paid Winslow Lewis, for fitting up with new lantern and 15 lamps, with 15 21-inch reflectors	3,600 00
		56,332 68

TREASURY DEPARTMENT,
Fifth Auditor's Office, December 28, 1841.

SIR: In my letter to the Committee on Commerce of the 14th of December, 1840, they were informed that a workman had been sent from France, at the request of this office, by Mr. Lepaute, the manufacturer of the lenticular apparatus, for the purpose of fitting up in the best manner two sets of lenticular apparatus in our two light-houses at Navesink, near Sandy Hook, and that it was expected the work would be completed before the close of the last year. In consequence of the inclemency of the weather,

however, this work was not completed and both lights in operation before the month of March of the present year.

While the light of one tower was extinguished and the work of putting up the lenses was in progress, a temporary light was erected and used, of the same character; and while the work of the second tower was in progress, the character of the temporary light was changed to suit the occasion, (the one being a stationary and the other a revolving light;) so that the character and appearance of the original lights were preserved, and vessels coming in from sea could readily recognise them, until both sets of lenses were fitted up and put in operation. The temporary light is still preserved with all its apparatus, to be used in case of any accident happening to either of the lens lights.

This being our first attempt to use the lenticular apparatus, the expense attending it has been greater than it would be in a similar case hereafter. The expense of a workman from France, who, coming to this country late in the season, was obliged to prosecute his work in the short days of winter, many of which were too inclement for him and those associated with him to work, the cost of a lantern made under his direction, amounted to nearly thrice as much as one can now be made for, and many other expenses incurred at his suggestion, can be avoided in future, if it be thought proper by Congress to authorize any more of the lenses.

Upon a rough estimate of the cost of these two sets of lenticular apparatus, of the first and second order, and putting them up upon two light-houses already built, it appears to be between \$23,000 and \$24,000.

The cost of these lenses, however, is nothing compared to the beauty and excellence of the *light* they afford. They appear to be the perfection of apparatus for light-house purposes, having in view only the superiority of the light, which is reported by the pilots to be seen in clear weather a distance of forty miles. It was my intention to have had the distance accurately ascertained by means of one of the revenue cutters; but I have not yet had an opportunity to do so. There are some drawbacks, however, in relation to their management, which would render them unfit for use in the United States, upon a large scale—there being but one lamp which supplies all the light, with three or four concentric wicks; and this lamp, made upon the Carcel principle, is very apt to get out of order and the light become extinguished, if the keeper be not an intelligent mechanic and capable at all times of making the necessary repairs.

We have been so fortunate as to obtain such a keeper at the Navesink—a man who can make every part of the machinery, both of the lamp and the clock work, and apply it in case of necessity without the least delay; and he is a man, moreover, who appears to take a pride in doing his duty in the best and most satisfactory manner. He has attached to him three assistants, taken from the class of seafaring men, who watch alternately every two hours through each night; and being near the city of New York, with which he can communicate in a few hours, he can always obtain men of a suitable character as assistants, and also all necessary materials for making every part of the machinery and keeping it in use.

I have the honor to be, very respectfully, sir, your obedient servant,
S. PLEASANTON.

Hon. JOHN P. KENNEDY,

Chairman Committee on Commerce, H. of Reps.

Extracts from the report of the Hon. R. J. Walker, Secretary of the Treasury, August 5, 1846. (Senate document, No. 488, 1st session, 29th Congress.)

In countries where the system of lighting is good, a general plan for the classification of lights, selection of sites, construction of the light-houses and apparatus, and inspection, has been adopted, or improvements have been slowly introduced under the direction of existing authorities. The most perfect system in Europe is the result of the former plan; and it must be obvious, that, for a growing country like ours, no other can secure, on the greater part of the coast, a due attention to the wants of commerce and navigation.

The unequal distribution of lights upon different important parts of our coast proves this, and shows how desirable it is that some general plan should be fallen upon, by which the claims of different parts of the country might be duly considered, a light provided wherever it is desirable to navigation, and expenditure saved when no such necessity exists; that, when a light-house was decided to be necessary, the site of the buildings should be properly selected, the buildings properly constructed so as to combine stability and economy; all the accessories, as store-houses for oil and for lighting apparatus, for fuel, and the like, properly arranged; that the lighting apparatus should be of the most approved kind and construction, and so placed as to illuminate the required parts of the horizon without waste; that the lights should be duly classified, so that, from the large sea-coast light to the small harbor light, the buildings, lighting apparatus, and accessories might be on the proper scale; the distinctive character for the lights adopted which experience has shown most effective, as fixed, revolving, fixed lights with flashes, successions of bright light and eclipses at regular intervals, and lights of particular colors; that when ready for illumination, the lighting apparatus may be properly kept and attended to, under effective inspection.

It is not possible to leave such things as these to local information, derived at second hand, or to chances, without paying dearly in the end for the want of system.

In all these points it appears that other countries have advanced rapidly; and it becomes us to see what improvements introduced elsewhere are adapted to our use, and to ascertain how our general system may be modified.

A comparison of the lighting apparatus in use with us, and of the improved apparatus of France, shows that in this essential our progress has not been as great as might have been desired.

The reports of the inspecting officers detailed from the navy to examine the lights on our coast showed their absolute defects; the present report shows their deficiencies relative to those of other countries. The trial made of one of the French lights, at the entrance to New York harbor, at Sandy Hook, has been very successful, but the use of this apparatus has not been extended. A light-house need be seen from particular parts of the horizon only; and as the lamps used throw off their lights almost equally on all sides, the direction of portion of the rays must be changed. This may be done by reflection from opaque substances, as from metallic mirrors; or by bending or refraction by transparent bodies, as by glass prisms or lenses. Much more light is lost by the use of the most highly

polished surfaces as reflectors, than by passing through transparent bodies; and hence lenses are more useful and economical for light-house purposes than mirrors. The refracting or lens apparatus invented in France by Augustin Fresnel, has been generally applied under the direction of his brother, Leonor Fresnel, the present accomplished secretary of the board of light-houses.

In this apparatus, lenses of glass are used to throw the light of powerful lamps in the required directions upon the horizon, and the part which would otherwise escape upwards is reflected to the horizon by glass prisms, so placed that the rays fall upon the back or second surfaces of the prisms, at angles at which they are entirely reflected. The lenses are built up of separate pieces of glass, thereby saving the weight and cost of large masses of material, besides diminishing the thickness, and thus preventing the loss of light by absorption, and permitting the figure of the surface to be adjusted so as to bring the rays accurately to a focus. If the lens apparatus be made to revolve, the navigator will see brilliant flashes of light, gradually growing dim, and succeeded by short intervals of comparative darkness; and if a second set of lenses, suitably arranged, revolve about the first, which remains fixed, a general illumination will be varied by brilliant flashes: these may be white or colored; and thus the appearance of lights may be so varied as to make them distinctive. A single large lamp, supplied with oil by mechanism, (as in French light-houses,) or by hydrostatic pressure, (as in some of the English ones,) is used with the lens system, and produces great economy in the consumption of oil necessary to supply a given quantity of light.

The dimensions of the apparatus are easily varied to suit the different quantities of light required, from the small harbor light to the large sea-coast light. In the French system, the lights are divided into four orders, the first being the most powerful; and each order may be sub-divided into a larger or smaller size. The best reflecting lights do not more than reach, in power, the second order of the lens system.

The advantages of the Fresnel or lens system are: 1st, in the greater brilliancy of the light; 2d, in the greater quantity of the more brilliant light thrown upon the horizon; and, 3d, in the less consumption of oil in obtaining these advantages. Simple experiments and calculations based upon them give an unerring means of ascertaining the relative brilliancy, quantity, and economy of different lights. If two lights are equally bright, they will illuminate equally two equal surfaces placed at the same distance from them. If one is brighter than the other, the brighter will illuminate equally the same surface when farther from the light; a fourfold brightness corresponding to a double distance, a ninefold brightness to a triple distance, and so on. Thus it is easy to compare the relative brightness of lamps, and adopting the light of some particular lamp as the standard, to describe other lights as equivalent in brightness to once, twice, or more times, the standard.

The useful effect of a light depends not only on its brightness, but on the extent of horizon which it can illuminate. The average brilliancy in different directions, multiplied by the extent of horizon over which it shines, gives its useful effect. Its economy is measured by this useful effect directly and inversely by the consumption of oil required to obtain it.

The careful experiments of Mr. Fresnel leave no doubt of the great advantages in respect to brilliancy, useful effect, and economy of the lens system, as may be seen by a few examples.

A harbor light on the lens system, of the smaller size of the fourth order, with a single mechanical lamp burning $1\frac{9}{16}$ th ounce avoirdupois of oil per hour, would give twice as brilliant a light as the ordinary reflecting system having a lamp burning $1\frac{3}{4}$ ounce avoirdupois of oil per hour. The quantity of light on the horizon would be double, the cost of a given quantity of light one-half, and therefore the economy twofold. As the apparatus increases in size from this to the higher orders, the advantage of the lens system increases. In the third order, second size, a mechanical lamp with a double wick, burning $6\frac{3}{4}$ ounces avoirdupois of oil per hour, gives as much light as fourteen lamps with reflectors, *each* burning $1\frac{3}{4}$ ounce avoirdupois of oil per hour. The useful effect is one and a half times, and the economy between three and fourfold. In the second order of lights the new system for equal useful effects is three times as economical as the old, reaching in the larger sizes to fourfold. A power equivalent to that of the first order of lens lights has not been reached by the reflecting system.

The cost of the erection of buildings for the new system of lighting, and the first cost of the apparatus itself, is somewhat more considerable, and the number of keepers required is greater than with the old; the repairs, on the contrary, are much less. An accurate comparison of these particulars shows that in France the economy is in favor of the new system. Thus, taking into consideration the interest on the cost of tower, lantern, reflectors, or lenses, and of keeping up the light, the relative expense of the two plans for a small harbor light is as 236 to the new to 226 of the old plan; while the quantity of light on the horizon is as 2 to 1 in favor of the new; and hence the economical effect is nearly double upon the new system. For a large revolving light (second order) the annual outlay for the old and new systems would be as 126 to 208, while the useful effect would be only as 1 to 2, and the economical effect of the new system would be more than one and a half that of the old. The cost for the lens apparatus might for the present be greater in our own country; but the economy in lighting by the lens system is too great for this circumstance to turn the balance against it.

The mechanical lamp, used with these lights, or some other which American ingenuity may supply, or the hydrostatic or pneumatic lamp in use in the English light-houses, will replace with advantage the present imperfect lamp. In France, the mechanical lamp is found to require but small repairs, readily made in establishments where the lamps are constructed; and both construction and repairs would surely be practicable here. The cost of repairs of the lens apparatus is in a series of years merely nominal, and experience has shown that it is more secure and more easily seen than the old. No important seacoast lights should be left without being watched by a keeper, and, in the economy in lighting, will much more than pay the cost of two keepers in the larger light-houses.

Whether the rapeseed oil generally used in the French light-houses may be employed in our own with advantage, is a question which cannot now be settled; it may, however, be desirable to call the attention of farmers to the cultivation of the plant from which it is obtained.

The use of the screw-pile, for the foundation of light-houses has, by rendering the establishment of permanent structures upon banks and shoals comparatively easy, safe, and economical, superseded in many cases the use

of light-boats, which, especially in exposed positions, are of comparatively little value.

The buoys used in the entrances to our harbors are now placed by local authorities, and under loose regulations. A general system should be adopted of coloring and numbering, and should be so rigidly adhered to that the seaman would know his position as soon as he discovered a buoy. This is practicable, as will be seen from the interesting account, in the report of Lieutenants Jenkins and Bache, of the intricate approaches to the port of Liverpool, which are rendered quite safe by the system of buoys, lights, marks, and tide signals. The natural marks which disappear yearly from our coast should be replaced by permanent ones; screw-piles for mooring buoys should in certain cases be supplied. The arrangements for placing buoys and verifying their positions require to be rendered systematic, and to be subjected to some general control. The navigator should have due notice of all changes from a source connected with the whole light-house system.

The best modes of lighting would be ineffective, unless the keepers were careful and intelligent persons, and instructed in the necessary particulars of the business. Some training is desirable. Frequent reports, and perhaps the suggestion in regard to keeping meteorological and tide registers, as a means of securing attention and intelligence, may be adopted.

* * * * *

Extracts from Senate Document No. 488, 1st session, 29th Congress.

[Lieuts. T. A. Jenkins and R. Bache, U. S. N.]

LIVERPOOL BAY AND HARBOR.

The buoys are constructed of both wood and iron. Those of iron are being pretty generally introduced by the surveyor. Six of the largest employed are of that material, and he expresses a decided preference for them, both in an economical point of view and as a matter of expediency. They are constructed with water-tight compartments, so that there is no danger of their filling should they be injured by a vessel coming in contact with them. Galvanized iron, both for buoys and for the hoops of wood ones, is highly approved of. The expense is the great obstacle. For buoys to be painted white, there can be little doubt of the great advantage of using the galvanized iron for hoops. Can and nun-buoys are employed. (See accompanying drawings.) The iron buoys require a weight to each to make them float properly in the water; but, once properly ballasted, there is no further difficulty with them in that respect. The buoys are of good sizes, fine proportions, and are distinguished by their color, shape, number, and name.*

* Thus: "Red buoys on the starboard hand, and black on the larboard, when running in."

"Black and white striped buoys upon intervening banks or flats."

Superior can-buoys, with perches at the "elbows or turning points of principal channels."

"Each buoy bears the initial of the channel it occupies, thus: F. *Formby channel*. C. *Crosby channel*. HF. *Half-tide Swathway*. N. *New channel*. H. *Horse channel*. R. *Rock channel*. HE. *Helbre swash*. B. *Beggars' Patch*. L. *Hoylake*. V. *Victoria channel*."

"The buoys are likewise numbered in rotation, No. 1 denoting the outer or seaward buoy of the channel its letter indicates."

Here, as in all the ports of the kingdom, red buoys are placed on the star-board hand of the channels leading from seaward, and the black ones on the port hand. The numbers commence from seaward. At the end of spits, or at turning points, perches are placed on the buoys (of iron.) So well and perfectly are the buoys distinguished, that a man, to go wrong, must be unable to read, or to distinguish colors.

The moorings of the buoys are heavy iron sinkers, so moulded as to increase their tenacity of hold, with the heavy chains sent from the light-vessels as unfit for use, although perfectly good and applicable to this purpose.

There are in the store duplicates of all the buoys; they are painted regularly once in six months, and their moorings raised every year.

The buoys and light-vessels are placed in their proper positions by the surveyor himself, the positions being fixed and decided upon by angles, so that the exact spots are known upon which to place them, and from which they are never allowed to be removed, unless alteration of shoals or channels make it necessary, (when it becomes necessary to consult the Trinity corporation, London,) or by accidents occurring to them; in which latter case a few hours only are allowed to elapse before they are replaced.

Registers of the buoys are kept, (see form,) showing when they were made, when repaired, and when placed, &c., with a column showing their positions by angles, remarks, &c. The present courteous and intelligent marine surveyor of the port of Liverpool, (Lieutenant Lord, R. N.) is greatly in favor of iron as a material, as well for light-vessels as buoys. The Northwest light-ship is 203 tons, and cost no more than one of the same size of wood would have cost, while the advantages in many respects are greatly on the side of the iron. The larger the vessel, the greater the economy of iron in comparison to wood. They draw but little water, (the Northwest only nine feet,) and are fitted with bilge keels to keep them from rolling too heavily. The greatest possible attention is paid to all moorings. Experiments have been made upon chains of different sizes, &c. Those in use at present are fitted with wrought iron studs, and have been found to answer infinitely better than those with cast iron ones; the former seldom or never falling out.

This corporation, not satisfied apparently with this perfect system of lighting, &c., has further provided for the safety of seamen by adding a number of life-boats to their charge. We are aware that this does not come strictly within the limits of our instructions; but finding it intimately connected with the light-house establishment, and having heard of the many and great benefits which have resulted from it as being a part of the most complete whole, we deem it but proper to refer to it in this connexion.

The boats, (nine in number) are placed at different stations around the bay, well provided and well protected from the weather, ready at a moment's notice for service. The crews are composed of experienced watermen residing near the stations of the boats, always willing and anxious to render assistance to those who may be so unfortunate as to strike upon the shoals, or meet with any other accident within the vicinity of the bay and harbor.

To insure a more certain and prompt assistance to those in distress, the corporation has an arrangement with the Steam-tug Company, by which, for the consideration of 400 guineas per annum, and 25 guineas additional for

every time a steamer is required, a vessel is ready at all times, day and night, with steam up, for towing out a life-boat, and for rendering any service that may be required.

A simple inspection of the chart of the bay of Liverpool will suffice to explain the manner of masking the lights, by which the positions of the buoys are pointed out by night to the pilot, so that he can stand on his course with confidence. The system is simple and perfect, meriting the warmest eulogies of all persons feeling any interest in the commerce of the port.

LIGHT-HOUSES OF SCOTLAND.

The "Commissioners of Northern Lights," who are charged with the control and management of light-houses, buoys, beacons, &c., of a general character, on the coasts of Scotland, were first instituted by act of Parliament in 1786.

The board is composed of twenty-five commissioners or members, whose services are gratis, and whose professions are of a civil character, but chiefly that of the law. There is not a single nautical person attached to the board.

There is a secretary to the board; and an engineer, who is the executive officer; an auditor; and an accountant, who prepares all accounts for the committees, &c.

The local or harbor lights, fifty-one in number, are under the control and management of local authorities and trustees, supported by dues levied upon the shipping visiting the respective ports where the lights are established.

The general board meets four times a year for the transaction of business. It receives and acts upon the proceedings of the committee meetings which have been held in the interim.

There is a standing committee, composed of sixteen members, called the "Bell Rock committee," which meets once a fortnight during the year, except in the months of April, August and September. This committee has charge of the lights, and appoints the finance committee, before which the auditor is required to lay all accounts twice a year, when they are examined and passed.

There is also a committee regulating "superannuated allowances," and one for "buoys, beacons," &c.

Committees are appointed for the superintendence of light-houses in the course of erection; and the board is in the habit of remitting any matters of importance which may arise to the consideration of a special committee, which examine and report upon them.

The engineer of the board attends upon all the committees. He executes all orders relating to lights, buoys, beacons, &c., and has the entire management of the executive department. He receives a salary of £700, and an allowance of £200 additional for clerk hire.

There are no agents for the inspection of lights. The engineer goes around to all the stations at least once a year, and reports the result of his observations to the board. There are two persons in the engineer's department: the "superintendent of light-keepers duties," who is charged with the delivery of stores at each station, accompanying the tender which de-

livers them, (which takes place generally twice a year,) reporting, on leaving the station, the condition in which he found the establishment; and, on his return, is required to hand over to the engineer the diary of his journey, in which is entered the observations made by him upon each station. The other person is the "foreman of light-house repairs," who, assisted by one or two men, goes, as occasions may require, to repair the lamps and light-house apparatus in general.

The engineer makes out a requisition once a year, according to a printed form, (hereto annexed,) for all stores that may be required for each light-house. These requisitions are submitted to a sub-committee, which rejects such items as may not be satisfactorily explained by the engineer, and approves all those deemed necessary for the service.

Printed forms are then issued to different parties, generally in Edinburgh, one of which each party retains, and returns the other, with the prices attached to each item required, accompanied by patterns or samples. The lowest tenders are always taken in the cases of ordinary supplies. There are no public newspaper advertisements for supplies; but applications are made to parties who are considered able to undertake the contract.

The supplies are delivered at the storehouse at Leith, compared by the engineer, the superintendent of light-keepers' duties, and the foreman of repairs, and, if found to correspond with the requirements of the tender, are received in store, from whence they are forwarded, in the tenders belonging to the establishment, to the different stations, as before mentioned. There are at present two light-house tenders, and it is proposed to build another, to be propelled by steam.

All applications for new lights, &c., are submitted to the standing committee. Examinations are made for proper sites, &c.; and if deemed necessary, after having obtained the approbation of the Trinity corporation of England, proceed with the work. The engineer presents the plans, specifications, &c., which must be approved by the board before the commencement of the work. The light-houses are generally built by contract, under the immediate direction and superintendence of the engineer of the board, and a superintendent who is not permitted to leave the spot, after the commencement of the work, until it is completed and received by the board. All extraordinary repairs are made in the same manner.

The buildings are constructed chiefly of the dark stone or granite peculiar to the coasts, in a plain, substantial manner. The oil cellars are fitted and finished with a proper care, as in England and France; the keepers' houses are separate from the towers, and differ very little in their general arrangements from those of England. One very simple and useful custom, of calling the keepers from their dwellings to the towers, a distance ordinarily of forty or fifty feet, was observed, which removes all necessity for the keeper to leave the light-room until regularly relieved. This consists of a small metal air-tube leading from the lantern to the room of the keeper, at the end of which are bells, which are struck by small hammers of wood, raised by blowing into the tube. The keeper, upon being called, answers in the same manner; the one making the call reversing the hammer of his bell after making the signal, so that the answer may be made.

The light-keepers' houses are furnished with spare rooms for the engineer, and for the workmen who visit the stations for making any repairs that may be required upon the illuminating apparatus. The furniture of these rooms is supplied by the commissioners.

The domes of the lanterns are all double-roofed of copper. No lightning rods are used.

The reflectors are parabolic, and generally twenty-one inches in diameter for the fixed lights, and twenty-four inches in diameter for the revolving lights.

The lights are distinguished very much as they are under the Trinity board, with some little modification. In a few cases there are two lights, placed one above the other, in the same tower—a plan not to be approved of under ordinary circumstances. The number of burners varies from one to forty-eight for each station, or from one to twenty-seven for each light-house; the average for each light being about twenty.

The lamps employed in the dioptric lights are the same as those employed in France. Those employed in the reflector lights are Argand fountain lamps, with burners containing wicks of about one inch in diameter. Great care is bestowed upon the manufacture of these lamps, which have their burners tipped with silver, to prevent their too rapid destruction by the great heat of the flame produced by them.

The Argand lamps are solidly made of brass, and of different forms; although those most modern, most approved of, and most in use, are fitted with a slide apparatus accurately formed, by which the burner may be removed from the interior of the reflector at the time of cleaning or wiping it, as also for trimming the lamp, and returned to exactly the same place, and locked by means of a key. The arrangement is an admirable one, as it insures the burner always being in the focus, and does not require that the reflector be lifted out of its place every time it is cleaned. The reflectors are securely screwed to the frame, and the focal points marked upon them for the flames of the lamps. The lamps are made in Edinburgh, and the reflectors in Birmingham, as a general rule. Lamps are also made in Birmingham. Great attention has been paid to the ventilation of the Scotch light-houses. Professor Faraday's tubes are highly approved of, although they increase the consumption of oil.

The engineer to the board of "Northern lights" has the entire management of the lights in the executive department. He selects his assistants to act under him in the construction of buildings, and visits the lights at least once a year. They are also visited by the superintendent of the light-keeper's duties, and by the foreman of the light-house repairs.

The light-keepers are appointed by the board. Should they fail in their duty, the engineer reports them to the board. There are two keepers at each light-house, one a principal, with a salary of £50 per annum, and an assistant, with a salary of £40 per annum. At the Bell Rock and Skerryvore there are one principal, one principal assistant, and two assistants; with salaries, for the keepers, of about £70, principal assistant £65, and the assistants each £60. In addition to their salaries, they are allowed each a suit of uniform clothing or watch cloak once in three years. They are also allowed a piece of ground large enough to produce grass for a cow, and a small garden. New keepers are instructed in their duties for three months.

In addition to the returns required of the keepers of their expenditures of oil and other supplies, they are required to keep a barometrical and thermometrical journal, with remarks upon the winds and weather.

They are supplied with timekeepers, and their dwellings are kept well painted and repaired: they were in good order.

There are no light-vessels on the coast of Scotland.

The beacons and buoys are under the immediate direction of the "committee;" under the direction of which they are placed, inspected, repaired, &c. The buoys are made of wood, and examined and painted twice a year.

"Since the rule for exhibiting the lights between 'sunset and sunrise' has been adopted in Scotland, an increased expenditure of oil has been occasioned. This increase, if we estimate four hundred and ninety-two burners at five gallons more throughout the year, which seems a fair allowance, is two thousand six hundred and forty gallons, or about £786 13s. 9d. per annum. The former rule, of making the 'going away and return of daylight' as the times of lighting and extinguishing, was departed from with a view to uniformity of practice."

[Circular.]

NORTHERN LIGHTS' OFFICE,
Edinburgh, , 184 .

I beg to acquaint you that the supply of the "best pale winter-bagged spermaceti oil," wanted for the use of the Northern light-houses for the year 184 , is tuns of two hundred and fifty-two gallons. If you intend to offer for this contract, your sample of one gallon of oil, carefully put up in an earthen jar, addressed to , light-house store, Leith, must reach him on or before the . The sample must be labelled with your private mark, without which no tender can be received, and which must also be referred to in your offer. It is to be understood that the quantity may, at the option of the purchasers, be ascertained either by the use of imperial measures, or by weight, at the rate of eight and three-fourth pounds, avoirdupois, per gallon.

In the month of , it is intended to send the light-house oil casks to London, where an officer of the board will examine the oil and give directions for shipping it. The oil must be put free on board, and all wharfage risks undertaken; but whatever may be required for the careful cooperage and cleaning of the casks, before filling the oil at the premises of the contractor, will be paid by the board. It may further be noticed, that the oil is measured and tried as to its quantity and purity, and burning quality, on being delivered into the stock cisterns at the several light-houses; and if then found faulty, it will be returned at the cost and charges of the contractor.

In reference to your sample, an offer to furnish any quantity that may be required from you, of from twenty to , at a specific rate per tun, to be paid for on the , must reach this on or before the , sealed and addressed "Tender for Oil," "To the Commissioners of the Northern Light-houses," and put under cover to "Messrs. Cunningham, secretaries to the light-house board, Edinburgh."

It may be proper to notice, for the government of those who make offer for this contract, that oil for the use of light-houses undergoes a most particular species of trial; each of the light-keepers, in his nightly management of the lamps, being perfectly acquainted with the properties of good oil.

In accepting an offer for supplying oil, the best sample is preferred to the

lowest price by the board. I beg further to notice, that you are requested to conform strictly to the terms of this letter, in offering for "pale winter-bagged spermaceti oil." If you have any other or different proposition to make to the light-house board, let it be in a separate communication.

Should any further information of a preliminary nature be wanted, application may be made to me.

An answer is expected to reach the secretaries on the , with or without an offer.

Unsuccessful offerers will, as usual, be paid half a guinea in name of charges for sample.

I am, &c.

Extract from a communication from Mr. Herbert, Secretary to the Trinity Board, to Mr. Cunningham, Secretary to the Commissioners of Northern Lights.

"TRINITY HOUSE, LONDON, February 21, 1844.

* * * * * "Although the catadioptric principle for light-house illumination has, in several instances, been adopted by the commissioners, (of Northern lights,) the Elder Brethren are desirous to draw the attention to the economical advantages which it possesses in certain cases, as affording ground for its more extensive use, whenever proper occasions for its application may present themselves."

* * * * *

Extract from the report of the committee of the Royal Society of Edinburgh, appointed to co-operate with the Commissioners of Northern Lights in 1836. Professor Forbes, reporter.

"The committee were requested to compare the new fixed dioptric light on the Isle of May, distant thirteen miles, with the old catoptric light, placed on a temporary erection near it."

After detailing the different appearances of the two lights, &c., in the body of the report, they say—

"The following conclusions seem to be warranted:

"1. That at a distance of thirteen miles, the mean effect of the new light is very much superior to the mean effect of the old light, (perhaps in the ratio of two to one.)

"2. That at *all* distances the new light has a prodigious superiority to the old, from the equality of its effects in all azimuths.

"3. That the new light fulfils rigorously the conditions required for the distribution of light to the greatest advantage.

"4. That at distances much exceeding thirteen miles, the new light must still be a very effective one, though to what extent the committee have not observed. The light is understood to be still a good one when seen from Edinburgh at a distance of thirty miles.

GREENOCK, V. P. R. S., Ed.

JNO. ROBINSON, Sec. R. S., Ed.

THOS. STEWART TRAIL.

R. CHRISTISON.

JAS. D. FORBES, Reporter."

The catoptric light, at the time of this comparison, was fitted with twenty-two large parabolic reflectors.

For Mr. Stevenson's opinions upon the subjects connected with dioptric lights, mechanical lamps, &c., reference may be had to his reports bearing date 10th December, 1834, Edinburgh; 27th October, and November 25, 1835; 8th October, 1836; December 10, 1839, &c.; and also his evidence before the select committee of the House of Commons, 1845.

Extract from the by-laws of the Commissioners of Northern Lights.

The duties of the engineer, generally, shall be—

1. To make all surveys connected with the light-house service in every department, either with a view to the erection of new light-houses, beacons, or other works, placing of new buoys, or the execution of repairs or alterations of the existing establishments.

2. To make and execute the designs of new works, to furnish the requisite plans and specifications, and superintend their erection.

3. To ascertain and cause to be executed the required improvements and repairs on the light-houses already erected.

4. To prepare for the consideration of the commissioners, the report of the principal alterations and improvements (if any) which is directed annually to be laid before the Parliament. This is to be laid before the commissioners one month previous to its presentation to Parliament.

5. To provide the estimated stores for the use of the light-houses, which is done by sealed tenders as far as practicable, and to distribute these to the different stations.

6. To regulate and superintend the light-house establishments at the different stations.

7. To superintend the shipping department.

8. To conduct the correspondence with the different light-house establishments, to call in all the accounts incurred in the department, examine them, compare them with the orders given, certify them, to try the calculations and check them, as also to allocate them to the branch of the service to which they belong.

9. To keep the requisite books and accounts of the distribution of the stores, so as to show the expense of maintaining each establishment.

10. To keep a register of all the harbor lights on the coast, and of any changes made in their character and position.

11. To visit all the light-houses once every year, and in the month of January, annually, to report their state during the past year, and their requirements for the ensuing year, to the commissioners.

12. To submit to the board the names of applicants to fill all inferior stations in his department, or in the shipping department; along with the names of the candidates, their respective certificates and testimonials shall be laid before the board.

13. All light-keepers are in the department and under the superintendence of the engineer, who is responsible for their observance of the rules and instructions from time to time issued for their direction; and also for their general good conduct.

14. In case of neglect, disobedience, or other serious fault, the engineer shall have power to suspend any light-keeper or other officer in this department,

but he shall forthwith report all such cases to the commissioners, by whom they shall be considered, and the offending party subjected to dismissal, or such punishment as the offence may merit.

NOTE.—To enable the engineer to discharge his duties, he is allowed the assistance of the officers previously named in his department; and though their duties are hereinafter specified, it is not thereby intended to limit their duties, but they shall act under the orders of the engineer in any other matters from time to time required of them.

The engineer is also allowed an annual sum to provide such further assistance as he may from time to time find to be requisite for the efficient discharge of his duties.

Extracts from the evidence of Mr. Alan Stevenson, Engineer to the Commissioners of Northern Lights, before the select committee of the House of Commons, 1845.

Will you explain the kind of burner you use? The dioptric burner, consisting of four concentric wicks, one wick within the other.

That is the French burner? Yes, the flame was very nearly four inches in diameter and about the same in height, or rather more now; it is now nearly five inches high.

You call that one burner? Yes; we call that one dioptric burner.

And one of those is equal to seventeen Argand burners? Yes; seventeen of the burners used for a reflector.

Was it not formerly estimated at fourteen as the proportion? From fourteen to fifteen.

But you find, from experience, that seventeen is the average? Seventeen is the average, if the flame be kept in its best or normal state.

Does that new glass applied to it increase the combustion? It increases the combustion, and renders it more perfect. Another improvement is the adoption of the ventilating tube, invented by Doctor Faraday, which I find of advantage in the dioptric apparatus; it causes a more perfect combustion, and raises the flame.

Has that been adopted in all your light-houses? It has in all the dioptric lights.

You state there are twenty-seven reflectors at the Pentland Skerries: supposing that light-house were changed to a dioptric light; what difference would it make in the consumption of oil and in the expense generally? I reported upon that subject to the board. That report at the same time notices a defect which is common to all fixed apparatus upon the catoptric principle. * * * In the line of the axis the light is the strongest; it gradually diminishes as you approach the sides, until you come to that part which is called by opticians the penumbra, where it is extremely feeble. * * * The saving of expense by the change referred to would be ten-twenty-sevenths of the whole.

Have you those reflectors in general use in Scotland? Yes; the lamp is placed in a position like this black mark upon the drawing, and about twelve-seventeenths of the whole light of the lamp falls upon the surface of the reflector, and is projected in a direction parallel to this centre line, which is called the axis of the mirror.

Then are five-seventeenths lost? Yes.

What have you upon the Skerryvore? In the Skerryvore the light is revolving.

Is it a French one? Yes, a dioptric one, with inclined lenses above and a set of lower zones not yet added.

What is the nature of that apparatus upon the table? This model represents a lens used in a revolving light, such as Skerryvore.

To prevent the loss of light above and below this principal lens, which in some measure answers the same purpose, *mutatis mutandis*, as the equatorial band of a fixed light, an arrangement of a peculiar kind is adopted: it consists of eight smaller lenses, inclined to the horizon at fifty degrees, and forming by their union a frustrum of an octagonal pyramid; the light falling upon the inner surface of these lenses is collected into parallel beams inclined to the horizon of fifty degrees, and above this are placed eight plane mirrors, whose action is to *reflect* these beams which have already been *refracted* by the small lenses, so as to throw them in directions parallel to the horizon, and thus to assist the action of the principal lenses; in this way the light which escapes above the lenses is turned to a useful purpose. This is the arrangement, with some few improvements, which was first adopted in 1823 or 1824 at the Cordouan light-house by M. Fresnel.

Do you consider much light is saved by that plan? A considerable portion; there is not, however, more than eight-tenths obtained in this way from that revolving apparatus, while in the fixed apparatus there are fully nine-tenths of the whole light.

If you had put up at Skerryvore, instead of the dioptric light, the old lamps and reflectors, which would have been the cheapest in point of annual expenditure? I hold that one of these lenses is equal to at least ten reflectors.

Which is most reasonable in point of annual expenditure? That would depend upon the number of reflectors employed to obtain a light of equal power.

Suppose you put thirty reflectors in the one, and instead of thirty reflectors you put a dioptric light; which would be maintained at the lowest annual expenditure? The French apparatus would be the cheapest in point of oil; it would be in the proportion of seventeen to thirty.

Then, what would be the ratio in point of expense: suppose one to be a thousand, what would be the diminution of that by adopting the dioptric light? The result would be in the proportion of seventeen to thirty, or 566.66 to 1000.

Nearly one-half the expense would be saved? Yes; a little less.

Do you consider the light-houses at present in Scotland are all provided with the best improvements which you can introduce? I think they are; I would recommend the substitution of the dioptric apparatus in several cases—to fixed lights in particular. The small apparatus is advantageous in fixed lights, but not in the revolving lights.

Do you contemplate any further improvements, or are any experiments going on which promise any improvement? No; I conceive the chief direction in which improvement is to be sought is in regard to the nature of the flame itself, and not in regard to the apparatus which modifies the light, which I think is nearly perfect.

What do you mean by the nature of the flame; do you mean gas? If we had a flame which had the property of being more intense, larger in

volume, and at the same time cheap, a very great improvement would be effected; but I do not myself know in what direction to seek for such a change.

Have you made experiments with gas, or with camphine, which has been lately introduced? No, I have tried some other substances; I have tried the vapor of naphtha.

In any of them have you found a superior flame? I have found nothing that I conceive warrants the running any risk in regard to the regular exhibition of the lights, which is more or less involved in the use of gaseous substances.

Then, since the inquiry in 1834, has there, in fact, been much improvement made in the mode of illuminating? The only practical improvements of which I am aware are those I have already described—the changes in the form of the dioptric fixed apparatus, and in the addition of the totally reflecting zones; also, in the changes in the form of the chimney, and the addition of Dr. Faraday's ventilating tube. There are, besides, some less important changes in the arrangements of the apparatus, which tend to economize the light. * * * * * The object in a light-house is not to get a very high flame, but a wide and steady flame; a flame that does not change its contour, but burns steadily.

Have you burnt a lamp with five wicks instead of four? Yes.

What has been the result of that? The result has been a greatly increased volume of flame, which is a great object in increasing the duration of the flashes in a revolving light, but it produces a great increase in the expenditure of oil—to the extent, I should say, of one-third.

You were examined in 1834 respecting the state of the light-houses in France: can you state if any, and what improvement has taken place since then? I am in constant correspondence with M. Fresnel, the engineer of French light-houses, and all the improvements which we have adopted have been adopted in France; while, on the other hand, we in Scotland have all the latest improvements in France.

Now, with regard to training: Do you place the light-house keepers under any particular training? They are required to reside six weeks at the Bell Rock, and six weeks at either Inchkeith or the Isle of May, so as to see both a dioptric light and a reflecting light.

Have you made any calculation what the expense would be of sending the oil and other stores required at the light-houses by public conveyances, if these tenders were not in use? No, I have not.

Do you believe that any saving would arise from that? I am inclined to think not; the loss of time would be considerable in making arrangements.

And a liability of damage to the stores? Yes.

Have these vessels ever been required unexpectedly for any particular duty; or do they merely take the routine at the proper seasons of supplying the stores? They are frequently required to go on a short notice, in case of any thing occurring. One very common emergency is the breaking of the panes of glass in the lantern. I have known instances where more than half the panes of the lantern were blown in by a gale of wind.

What kind of glass do you use? Very strong plate-glass, a quarter of an inch thick.

And that has been blown in? Yes, it has on two occasions within my recollection, at Dunnethead; and sometimes sea-fowl have come through.

Then, in your opinion, that department could not be more economically conducted than it now is? No, I think not; not certainly by trading vessels.

IRISH LIGHT-HOUSE ESTABLISHMENT.

The light-houses, light-vessels, buoys, beacons, &c., of Ireland are under the control and management, with certain restrictions, of the Ballast board of Dublin, a body incorporated by act of Parliament for the preservation and improvement of the port and harbor of Dublin. This board is composed of twenty-two members, viz: the lord mayor and high sheriff of Dublin, who are *ex officio* members; three aldermen, elected by the board of aldermen of the city; and seventeen members who are elected for life, consisting chiefly of merchants—there being, however, one seaman at present (an admiral in the navy,) and one banker. The following persons are attached to the board, viz: a comptroller, a secretary, an inspector of works, and his assistant, who perform the ordinary and extraordinary duties required of engineers in other light-house establishments; a superintendent of light-vessels, (a lieutenant in the navy,) who performs all duties relative to the placing, replacing, fitting, mooring, &c., of the light-vessels, and all details relating to that particular branch of duty.

The erection of new light-houses, the placing of new beacons or buoys, or any other change in the establishment involving the levying of tolls or duties from shipping, requires the consent and approbation of the Lord Lieutenant of Ireland and the council, and also the approval of the Trinity board of London, before any steps can be taken relative thereto.

The inspector (engineer) and his assistant draw all the plans and specifications for the buildings, under the instructions of the board. The board, or a committee of them, visits the location, and with the advice of the engineer selects the site. The site thus selected is surveyed and reported upon to the board for its final action.

There is no committee from this board charged with the details of the light-house establishment. The board devotes one day in each week to the business of the light-house department; their orders being executed by the inspector, who is in reality the executive officer.

The light-house towers and other necessary buildings are built chiefly by contract, in the usual form, through a public newspaper advertisement, and under the usual restrictions to insure the faithful performance of the contract. The engineer or inspector of works has the charge and superintendence of all new works, and repairs of old ones. There is also a foreman of works, who is required to be present during the time the works are in the hands of the contractor; and he is not, under any pretence, permitted to leave the work until it is completed and received by the proper authorities.

The materials in most common use are stone. Brick is employed for the interior walls of dwellings occasionally. The situation of the light decides, in a great degree, the kind of material proper to be employed. If the tower is to be placed upon an exposed point, where the action of the sea may reach and affect it, then cut stone is used; but if placed on the main land, and unexposed to the sea, then the material in general use is hammered or rubble-stone, laid with good strong mortar in courses. This latter mode of construction is employed from motives of economy. It has

been ascertained that hammered and rubble-stone towers, when well and properly constructed with strong lime-mortar and good sand, answer very well in that climate. The towers are generally painted outside, and in some instances they are lathed and plastered inside, leaving a space for ventilation between the walls and the plastering. These towers are ordinarily sufficiently smooth to receive paint without the addition of extra plaster or rough-casting.

Great attention is paid to strength and durability in all the works of the ballast board.

The light-keepers' buildings, interior of the towers, lanterns, &c., are fitted and furnished with a proper attention to efficiency, comfort, and economy.

Owing to the very careful and substantial manner in which the buildings are constructed they require very few repairs, except an occasional painting.

All repairs of an extraordinary character are made by contract—ordinary or small repairs by day labor; all, however, under the direction and immediate superintendence of the inspector or his assistant, (engineer,) and in the presence of the foreman of the works. * * * *

The inspector, or his assistant, examines all articles received at the store on contract, and compares them carefully with the samples and the requirements of the contract before receipting for them. No experiments have been made in Ireland to test the practicability of using gas, or any other light than that produced by oil, in Argand burners, for light-house purposes. The oil is kept in iron tanks lined with tin.

A rigid system of accountability is practised in the ballast board. The bills are certified by the foreman and clerk of the works, examined and certified by the inspector; afterwards examined by the comptroller, then by the secretary, to see if they correspond with the contract prices. Having gone through these different offices, if correct and no objections made to them, they are reported to the board, and, after being examined, are ordered (if approved) to be paid.

Two of the light-houses on the coast of Ireland have three keepers; they are, however, on tidal rocks, which require shore stations to be attached to them. All others have two keepers—one principal and one assistant keeper. They receive as follows, viz: Principal keeper £64 12s. 4d., and assistant keepers each £46 3s. per annum.

The keepers are furnished with printed instructions for their guidance, with the various printed forms for monthly and quarterly returns of oil and other stores, &c., as in England and Scotland, and a meteorological journal.* The inspector, or the assistant inspector, visits at least once a year all the light-houses under his charge, and very frequently those in the course of construction or repair. The members of the ballast board never visit the lights officially, although some do so occasionally in their private or individual capacity. The engineer is more particularly charged with the examinations, inspections, and tests of the different illuminating apparatus.

The stores of all kinds are sent from the store in Dublin, under charge of the store clerk, to the different light-stations, by the tender to the board, and occasionally by vessels chartered for the purpose.

* See the printed forms and instructions hereto annexed.

There are three light-vessels belonging to the coast of Ireland. One of these vessels has three lanterns, with eight burners and reflectors each; another two lanterns, with eight burners and reflectors each; and the third has but one lantern, with sixteen burners and reflectors: making a total of fifty-six burners afloat.

These vessels are constructed of wood; are moored with single mushroom anchors weighing from one and a half to two tons; the chains are from $1\frac{3}{4}$ to 2 inches in diameter, with studs. They are under the charge and management of the superintendent of light-vessels; they are well found in every particular. The spare light-ship is always kept in readiness for replacing either of the three riding ones in the event of their drifting, or any other accident happening to them.

The system of relief similar to that in England is allowed to the seamen on board of the light-vessels. There are a few boys employed on board, who receive rations and clothing from the board for their services.

* * * * *

A screw-pile light has been recently erected in Belfast bay by Mr. Mitchell, for a harbor light and pilot station. The light is a fourth order smaller model dioptric, with a red chimney. It stands firmly, and is doubtless a successful experiment; if, indeed, it may be termed an experiment, after the success of the one at the Maplin sands and mouth of the Wyre.

The buoys are constructed of wood: they are painted of different colors—red, black, black and white, diagonal lines, &c. They are ordinarily moored with heavy sinkers of stone, which cost only about one-eighth as much as those of iron.

Iron beacons, screwed into their positions by Mr. Mitchell, are used in Ireland. The one on the Kish bank has been up a sufficient length of time to test the practicability of the mode. The ballast board has it in contemplation to introduce more of them. The ordinary land beacons are constructed of different materials.

Mitchell's screw moorings for mooring buoys have been introduced very successfully in Dublin harbor, and it is proposed to introduce more. The screw for these moorings is precisely similar to that for the screw-pile.* Three or four hours of good weather is sufficient to place one of these moorings; which, when properly placed, will hold several vessels, and answers most admirably for warping against a strong tide. They are considered advantageous in an economical point of view.

* * * * *

Extract from a communication from the secretary of the Trinity Board, London, to the secretary of the Ballast Board, Dublin.

“The elder brethren, in making this communication, deem it advisable to request the attention of your board to the comparative economy of the catadioptric principle of illumination in all instances in which a powerful light of extended range is required; and in so doing remark that, as the elder brethren are informed, the light at Tory island is exhibited by the effect of forty Argand burners and parabolic reflectors, while a light of equal power would be produced by a catadioptric apparatus, illuminated by a

* See drawing accompanying this report.

single lamp with concentric burners, expending a quantity of oil equal to the consumption of no more than fourteen Argand burners. The elder brethren are aware that at some stations the lanterns are not glazed sufficiently high to admit of the introduction of the complete apparatus of mirrors, but the omission of one or two of the catoptric tiers would not be of importance in respect of practical effect, and would obviate all necessity for an expensive alteration of the lanterns."

Extract from the evidence of Mr. Halpin, assistant inspector of the Irish lights, before the select committee of the House of Commons of 1845.

"Is there any other information you wish to lay before the committee relative to the light on the Kish bank? The object of the board in proposing to erect a light on the end of this bank was, that they should exhibit a steady, brilliant, and powerful light, not affected by the motion of the sea, as in the light-ship—not liable to drift, or similar casualties; and the board thought the many advantages resulting from a fixed light was sufficient to warrant their going to the expense of erecting it; besides, when the light was once finished, the expense would be much less than that of the light-ship. A light-ship requires sails and rigging, and a crew of eight or ten men, in case of accident. In every way the expense is considerably more than that of the fixed light.

"In every point of view, you think, if this work of the Messrs. Mitchell was carried out, it would be a great benefit to the shipping? It would be a decided benefit in every respect, if completed. I think, from what I have stated, the committee will see the advantages that will result from it; but there must be a certain risk in every thing of that kind.

* * * * *

"Have they any intention of altering it? They would have no objection to alter it, if they could get an equally good oil. I think it is not a saving to get a cheap oil and exhibit a bad light; life and property are of more consequence than a little saving in the price of the oil.

"Have you any other observations to make? I may remark, with respect to dioptric lights, although the ballast board have only one at present in use, they have ordered the three towers now in progress to be fitted with them, and purpose introducing them wherever there can be a positive advantage from their adoption. I consider that where much more than one-half the circle is illuminated, there is an advantage in the dioptric light, and there is also a more equal diffusion of the light from it.

"For fixed or revolving lights? Principally for fixed lights; they have not resolved upon adopting it for revolving lights.

"Have they come to that determination from a conviction of the superiority of the dioptric light over the common reflectors? Chiefly on grounds of economy.

"You say there is a superiority in the light? There is a somewhat more equal diffusion of the light around; between the angles of divergence of the reflectors there is some inequality in the strength of the light, but in a well arranged reflecting light there is no very great difference from a refracting light, unless in point of economy."

FRENCH LIGHTS.

The light-house department of France is attached to the official duties of the minister, Secretary of State for the Interior, and is under the immediate control and direction of the Minister of Public Works, charged with the administration of the bridges and roads.

A central public board has the management of all light-houses, buoys, beacons, and sea-marks on the coasts, which is composed of eleven distinguished scientific and professional individuals, who are appointed by the government, including the engineer, secretary to the commission, and his assistant. This board is presided over by the Minister of Public Works, and in his absence by the Under Secretary of State for that department.

This mixed commission, called the "Commission des Phares," is composed of naval officers, (of whom there is a majority,) of inspectors of the corps of bridges and roads, and of members of the institute. It prepares the projets for all new lights, and the general council of bridges and roads judges of the propriety of all schemes for that branch of service, under the four heads of architectural design, mode of executing the works, estimate of the expense, and the preparation of the specifications of the works. The light-house commission of France is not an administrative body, but is occupied solely in questions of principle or design, and leaves to the general directory of bridges and roads the care of providing the necessary means for the construction of new works, the expenses of illumination, &c.

The central commission at Paris is charged with the duty of providing all supplies necessary for keeping the illuminating apparatus in perfect order. There is also in Paris, belonging to this particular branch of the public service, a central workshop and depot, under the immediate care and supervision of the secretary-engineer to the commission, who superintends the construction (by mechanics employed by the administration) of all lanterns and their fixtures that may be required for the service; tests all apparatus before sending it to its destination; makes experiments upon all the optical and mechanical portions of apparatus destined for light-house purposes, combustibles, &c.; in short, this officer is charged with all the scientific details of the service, subject to the instructions, from time to time, which may be issued by the light-house commission. At this central depot are always kept, ready for immediate use, the various articles required in the illuminating department; such, for example, as mechanical and Argand lamps, glass chimneys, wicks, cleaning materials, &c.; also specimens of the different descriptions of apparatus used in light-houses, and apparatus constructed upon the latest and most approved plans ready for service.

All expenses incurred in the maintenance of the lights and their appendages are defrayed by the agents of the national treasury, from funds authorized by annual appropriations for those specific purposes.

No light dues are charged upon shipping in France, as in Great Britain, Holland, Denmark, Norway, and Sweden, &c.; but the whole establishment is provided for as in the United States and Russia.

The maintenance of the light-house buildings is confided to the departmental or local engineers, and the expenses are defrayed from funds appropriated for the service of the department of public works.

The establishment of new works is decided upon by the Minister of Public Works, under the advice of the light-house commission. The deter-

mination of the minister is reported officially by the secretary of the commission to the Under Secretary of State for that department, and through his office to the prefect of the department in which the proposed work is to be established. The prefect directs the chief engineer of bridges and roads for that department to have detailed plans and estimates prepared upon the basis of the proposition of the light-house commission; these plans and estimates are transmitted through the office of the Under Secretary of State to the secretary of the light-house commission, who makes a report to accompany them to the light-house commission. The plans and estimates are then submitted to the light-house commission, which decides whether or not the wants of the service, *nautically* or *otherwise*, are such as to require the construction of the proposed works. In the preparation of these plans and estimates the military engineer of the department is consulted, to ascertain his opinions as to the propriety of constructing these works with reference to the defences of the coast.

The details having been completed, after having undergone the strictest scrutiny in every particular, the projet is presented to the general council of bridges and roads, to be considered with reference to the architectural designs, mode of construction, estimates of expense, &c. Having been approved by the general council of bridges and roads and the Minister of the Interior, the plan is then sent to the prefect of the department in which the light is to be established, with instructions to enter into contracts for the execution of the works, under the specifications and limitations authorized by the administration.

The execution of these works is entrusted to the engineers of bridges and roads for that department. As the works advance, the contractor receives payments upon the certificates of the engineers in charge, approved by the prefect of the department, from the departmental paymaster, (as deputy of the public treasury,) and the sums are charged to the budget for works of navigation, under the head of light-houses.

The light-house towers of France are constructed in the most substantial and perfect manner possible, without there being any appearance of unnecessary or wasteful expenditure. Great care is taken in the interior arrangements of the buildings, so that they may best answer the requirements of the service. Many of the towers are constructed of a soft stone of a rather peculiar kind, which hardens by exposure to the action of the atmosphere: those constructed of that material are lined inside with brick, leaving a sufficient space between the interior of the outer wall and the brick to allow a free circulation of air, thereby securing the building from dampness. Hard burnt bricks are preferred for light-house towers, when circumstances will admit of their being employed, particularly in fitting up the oil apartments, which are placed below the surface of the earth, to insure as equable a temperature during the whole year as may be possible to attain. The keepers' apartments are finished and fitted up in a plain, substantial, and economical manner, combining all the necessary accommodation and comfort. There is a room fitted up and properly furnished for the accommodation of the engineer, inspector, or other person authorized to make official visits at each light station. Especial care is taken to secure proper ventilation to the towers and lanterns—all the necessary fixtures about the light-rooms, lanterns, apparatus, &c.—the most minute, and apparently unimportant details in the exterior and interior arrangements; in short, nothing could combine greater perfection in stability, in usefulness, and a

proper economy, than is perceptible in everything connected with the light-houses visited by us on the coasts of France.

The repairs of the light-houses and their appendages are projected and executed by the engineers of the different departments in which they exist, who are limited as much as possible in their expenditures by the estimates of each year for those specific purposes. In some cases the contractor-general is authorized to make repairs, under the direction of the agents of the administration of bridges and roads.

Whenever application is made for a new harbor light, the subject is submitted to a local commission, assisted by the engineers of the department. The report is discussed by the light-house commission, and the same course subsequently followed as in the case of large or seacoast lights.

All the light-house towers in France are furnished with lightning conductors, made of copper wire twisted into the form of a rope, and about three-fourths of an inch in diameter.

In the organization of the lighting service, two systems are followed: the contract and the administrative. The ocean and Mediterranean coasts are under contract at present for nine years from 1839, for all the detail supplies of the service. * * * * * Among the clauses and conditions, it will be perceived that the contractor-general is required to be represented by a deputy in each department in which there are any lights; that the *oil of colza, clarified and refined*, must be used exclusively; and that the prices of oil will be regulated quarterly, based upon the average prices of the principal market in the kingdom for that particular article of commerce. M. Fresnel insists that this last clause has had a most salutary effect of insuring the best oil the market could produce, without the contractor running any risk of loss. On the coast of the channel, from the frontier of Belgium to St. Malo, this service is performed by the administration, except for the article of oil, which is procured under a contract entered into for three years. That portion of the coasts of France which is lighted by contract includes even the salaries of the light-keepers; but where the service is performed by the administration, the keepers are appointed by the prefect of the department, upon the recommendation of the engineers. The smaller articles necessary to the illumination are sent from the central depot in Paris, under the charge of a conducting steward. The mechanical lamps are sent to Paris to be repaired under the engineer-secretary to the light-house commission. The administrative system recommends itself, for the reason that it avoids all intervention of interest foreign to that for which the lights were established. The contract system has been for a long time preferred in France, for reasons of economy, complication of accounts when performed by the administration, &c.; but the experience of the last seven years on the channel coast has sufficiently demonstrated the importance of changing it to the administrative; and it is deemed quite probable, that, after the expiration of the present leases, that system will be exclusively adopted, except for supplies of oil.

The superintendence of the lights of France is confided to the local engineers of the corps of bridges and roads. The secretary to the light-house commission visits, each year, one of the three divisions into which the coast is divided, and his assistant another, so that the inspections, as far as possible, are biennial for each division. Monthly returns are made of all stores on hand, of the quantity of oil consumed each night, &c., to the secretary of the commission. These returns are intended as checks upon the keepers.

and answer the purpose admirably. A most rigid supervision is required at the hands of the inspecting engineers; and, moreover, that they employ all possible means to detect any delinquency on the part of the keepers, or other agents connected with the service. It is conceded that all these precautions may fail to produce the desired effect, but that under such a supervision few among the guilty will escape detection. The lights visited by the undersigned were clean, and presented every indication of a perfect and systematic attendance and supervision.

Indications of the range of visibility afford very meagre data for forming a correct idea as to the relative value of apparatus for illumination. It is impossible to determine with certainty the *absolute range* of any light, in consequence of the different conditions of the atmosphere, and of the capacities of the different observers. A first order dioptric light has been seen *fifty* miles very often, and one of the fourth order as far as sixteen miles. M. Fresnel says upon the subject of range: "We would, then, draw very erroneous conclusions as to the relative value of the useful effect of the apparatus of these lights, in taking for a basis of comparison the indications of *range*, which are never fixed or positive."

At the present time there are two systems of illumination in France—the old or reflector system, and the new or dioptric system. In 1822 M. A. Fresnel placed the first dioptric apparatus ever successfully employed, in the tower of Cordouan, at the mouth of the Gironde. In 1825 the lighthouse commission decided upon the exclusive use of the lenticular apparatus for the illuminations of the coasts of France and colonies; adopting, at the same time, the programme and report of Rear Admiral de Rossel, who had been charged, as a member of the "Commission des Phares," with that service.

Since that period new lights have been established, and old ones replaced with this new apparatus, until, on the 31st December, 1845, there were, of the two hundred and nine lights of every description belonging to the lighthouse department of France, one hundred and nineteen fitted with that apparatus. The remaining ninety lights were reflector lights, fitted with the Bordier Marcet (called "sideral") reflectors, and the parabolic reflectors, similar to those used in Great Britain and America. Of these last ninety lights, seventy-seven are small harbor or temporary lights, fitted, in most cases, with a single parabolic or Bordier Marcet reflector, marking the entrance to some channel or harbor. The remaining thirteen are fitted with lenticular apparatus of the most approved construction, in accordance with the original plan of 1825.

Engineers and other scientific and philanthropic individuals, of most if not of all the nations of the world, have made this new system of illumination an object of study and of critical examination; the results of which have been the successful, though gradual application of it to the coasts of nearly all the commercial nations.

On the 31st December, 1845, *eighty-three* light-houses belonging to foreign governments had been fitted with lenticular apparatus, constructed in Paris; to which may be added those constructed in England and Holland, say from fifteen to twenty, making, including those on the coasts of France, upwards of two hundred and ten; one hundred of which may be put down as of the three first orders, and the remaining one hundred and ten of the fourth order. These numbers do not include those at present in the course

of construction for France, Egypt, (tower at Alexandria,) Brazil, and the colonies, islands in the Pacific, &c. M. Fresnel says, with perfect truth and reason: "After these numerous and extended applications, the dioptric system of lights may be fully appreciated under the double aspect of *theory* and *practice*; and I will add, that under the first point of view the question has been for a long time out of controversy."

There are six different orders of lenticular apparatus at present employed, viz: first, second, third larger model, third smaller model, fourth larger model, and fourth smaller model order.

The different orders are subjected to different combinations, such as dioptric, two catadioptric, one with concave mirrors, and the other with catadioptric zones, or rings of glass, in triangular profile sections, and the "diacatoptric,"* combining the dioptric portion and the catadioptric zones surmounted by plane mirrors. In addition, a spherically curved metallic reflector or mirror is placed on the land side of all lights which are only required to illuminate from four-fifths to five-sixths of the horizon, which reflects the rays from that side, back through the opposite lenses.

"There can be no doubt," says a distinguished engineer,† who has had much to do with the light-houses of Europe, "that the more fully the system of Fresnel is understood, the more certainly will it take the place of all other systems of illumination for light-houses, at least in those countries where this important branch of administration is conducted with the care and solicitude which it deserves." "To the Dutch belongs the honor of having first employed the system of Fresnel in their lights." "The commissioners of northern lights followed in the train of improvements, and in 1834 sent Mr. Alan Stevenson on a mission to Paris, with full powers to take such steps for acquiring a perfect knowledge of the dioptric system, and for forming an opinion of its merits, as he should find necessary." "The singular liberality with which he was received by M. Leonor Fresnel, brother to the late illustrious inventor of the system, and his successor as secretary to the light-house commission of France, afforded Mr. A. Stevenson the means of acquiring such information and making such a report, on his return, as to induce the commissioners of northern lights to authorize him to remove the reflecting apparatus of the revolving light at Inchkeith, and substitute dioptric instruments in its place." * * * * "The Trinity House followed next in adopting the improved system." * * * Other countries begin to show symptoms of interest in this important change; and America, it is believed, is likely soon to adopt active measures for the improvement of their light-houses. "Fresnel, who is already classed with the greatest of those inventive minds which extend the boundaries of human knowledge, will thus, at the same time, receive a place amongst those benefactors of the species who have consecrated their genius to the common good of mankind; and wherever maritime intercourse prevails, the solid advantages which his labors have procured will be felt and acknowledged."

The fourth order lenticular lights are illuminated ordinarily by means of a common fountain, or constant level lamp and Argand burner, with a single cylindrical wick of three-fourths to seven-eighths of an inch in diameter, consuming about one and a quarter ounces of oil per hour, and forty-eight gal-

* See Mr. Alan Stevenson's report to commissioners of northern lights, for this word.

† Mr. Alan Stevenson, civil engineer.

lons per annum. The larger lights require mechanical lamps with multiple wicks, to as great a number as four, placed in concentric tubes, and the oil supplied to them by means of pumps, put in play by clock machinery. Hydraulic and pneumatic lamps have been employed in the place of the mechanical ones, but, with good reason, they are not approved of in France. For the catadioptric apparatus of half a metre in diameter, the ordinary constant level lamps, with two concentric wicks, burning about four and a half ounces of oil per hour, have been employed very successfully at several points on the coast of France, where the ordinary range of a light of the third order, for example, was not required, or for harbor lights requiring a powerful ray, or one whose brilliancy it is necessary to weaken by the application of a red chimney, with the view to give it a distinctive character. These double wick ordinary lamps require only one keeper to attend to them. Some of the burners in France are fitted with flat wicks for small and temporary lights, although by no means common, and generally disapproved of.

The dioptric lights of France are divided into six different orders; but, with reference to their distinctive characteristics and appearances, this division does not apply, inasmuch as, in every order or class, lights of precisely the same character may be found, differing only in the distance at which they can be seen, and in the expense of their maintenance. The six different orders, as before mentioned, are not intended as distinctions, "but are characteristic of the power and range of lights, which render them suitable for different localities on the coasts, according to the distance at which they can be seen." "This division, therefore, is analagous to that which separates the lights of Great Britain into sea-lights, secondary lights, and harbor lights; terms which are used to designate the power and position, and not the appearance of the lights to which they are applied."

In France there are nine principal combinations of lights possessing distinctive characteristics. These distinctions, for the most part, depend upon the periods of revolution rather than upon the characteristic appearance of the light. They are—

1. Flashes, which succeed each other every minute;
2. Flashes, which succeed each other every half minute;
3. Flashes, alternately red and white;
4. Fixed lights, varied by flashes every four minutes;
5. Fixed lights, varied by flashes every three minutes;
6. Fixed lights, varied by flashes every two minutes;
7. Fixed white lights, varied by red flashes more or less frequent;
8. Fixed lights;
9. Double fixed lights.

There are very few double fixed lights in France. They are, however, sometimes employed for the purpose of giving a very decided character to the locality. For example, the first order lights at La Hève, near the port of Havre, and the two lights at present in the course of construction on the left bank of the *Canche*. Red fixed lights are not employed on the coasts of France, except as a distinguishing characteristic for harbor purposes. They are doubly objectionable: first, because of the great diminution of light in consequence of the absorption of the red glass chimney;

and, secondly, it loses its distinctive character in foggy weather—all lights assuming a reddish tint under those circumstances.

The revolving reflector lights are objected to because of the fact that, ordinarily, they are only distinguishable by the duration of their eclipses, which often become positive at a very short distance from the light-house, and the interval of time between any two eclipses could not be extended to a greater limit than three minutes without prolonging the duration of the eclipses to such an extent of time as to mislead the navigator by depriving him for so long a time of his point of recognition. In the revolving dioptric apparatus, upon the latest and most approved plan, the duration of the eclipses is scarcely perceptible; the fixed subsidiary parts of which reflect a light constantly visible in a horizon extending nine or ten nautical miles with a second order, and from twelve to fifteen with a first order apparatus.

The three first of the principal combinations only are applied to the first three orders, in consideration that in the inferior orders the flashes would have too short a duration, and the eclipses would be positive at too short a distance from the light, in consequence of the feebleness of the ray produced by the fixed subsidiary part of the apparatus.

The distinguished engineer, secretary to the "Commission des Phares," of France, M. Leonor Fresnel, kindly furnished the undersigned with the results of numerous photometric experiments which were made for the purpose of testing the comparative useful and economical effects of the two systems of illumination, to which they beg leave to call particular attention.

M. Fresnel says, in his note referred to, "the foregoing results confirm the following principles:

1. "The *useful effect* of a parabolic reflector increases with its dimensions, and with that of the illuminating body.

2. "The *economical effect* of a reflector of given dimensions is greatest when the lamp-burner is smallest.

3. "The *divergence* is greatest when the flame is most voluminous, or when the reflector is smallest. We cannot then (all other things being equal) augment the *economical effect* of a reflector without diminishing its useful effect—that is to say, without reducing its brilliancy or intensity, and consequently its range (*portée*.)

"The reduction of the volume of light within certain limits is particularly objectionable when it appertains to eclipse apparatus, in which case it limits the width of the luminous cone, and consequently augments the length of the eclipses. The same reduction applied to the foci of reflectors composing a fixed light apparatus may weaken the light in their intervals to such a degree as to produce *dead angles*, or become completely obscured to the observer beyond certain distances.

"It is further proper to remark that the horizontal divergence is not lost for *useful effect*, but that the divergence, in the vertical sense, only profits the navigator in the limited angular space comprised between the tangent at the surface of the sea and the ray terminating at the distance of some miles from the light.

"Finally, there is for the caliber of the lamp-burners applicable to reflectors of given dimensions, and destined for the illumination of an equally determined range, a *maximum* beyond which prodigality of light ensues, and a *minimum* within which the illumination becomes insufficient."

The third order smaller size lenticular apparatus may be illuminated with

very decided advantages by means of an ordinary Argand burner and single wick. Such a light would consume about two ounces of oil per hour, and is admirably adapted for harbor lights. In ordinary weather such a light may be seen from twelve to fifteen miles. One keeper alone can attend to all the duties of such a light, and it is maintained in France at an annual expense of about two hundred dollars.

M. Fresnel remarks, with reference to the ranges of different lights, their useful effect, &c :

“The useful effect of a light-house apparatus is measured by the quantity of light which it projects upon the horizon. Observations of *range* for that purpose furnish very uncertain evidences, on account of the difficulty of ascertaining the *absolute range* of a light, which varies according to the state of the atmosphere and according to the good or bad sight of the observers.”

Reflector lights, with not more than six or eight burners, are attended by one keeper, occasionally assisted by the members of his family. For lights with a larger number of burners, two keepers; and if the light be in an isolated position, three keepers are allowed, with, in the latter cases, certain privileges not accorded to others.

Dioptric lights of the fourth order and third order smaller size, require but one keeper, except when in isolated positions. Two keepers are allowed to lights of the third order larger size, and for those of the second order, in consequence of the employment of the mechanical lamp.

First order lights are allowed three keepers; and when there are two first order lights forming one combination, five keepers are allowed for the two lights. Lights of the first order on isolated positions, are allowed four keepers, and for the third order larger size and the second order lights, similarly situated, three keepers are allowed.*

In comparing the two systems of illumination, they should be considered under the heads—first, of absolute useful and economical effect; second, of first cost, repairs, and maintenance; and, third, of the facility and safety of the service.

The brilliancy of a catadioptric apparatus of 11.8 inches interior diameter, lighted by a lamp burning forty-five grammes of oil per hour, has been found, by photometric experiments, to be equal to eight or nine Carcel burners; while that of a “sideral” reflector of Bordier Marcet, illuminated by a lamp consuming fifty grammes of oil per hour, has been found, in the same manner, equal to only four burners of Carcel; or, in other words, the brilliancy of the former is to the latter as one to two. The useful effect of the catadioptric apparatus, illuminating three-fourths of the horizon, is represented by 137,700, and that of the reflector by 68,400, which gives the value as one to two.

The economical effect of the catadioptric apparatus is represented by 3060, and that of the reflector by 1368; giving the value in that respect as 1 to 2.24.

No combination of reflectors can produce an equivalent to the third order smaller size apparatus, illuminated by an ordinary fountain lamp and Argand burner, with one wick, consuming sixty grammes of oil per hour, or one burner, with two wicks, consuming one hundred and fifteen grammes of

* In England, Scotland and Ireland, no difference is made between the number of keepers for dioptric and reflector lights.

oil per hour. An apparatus of this sort, with a lamp of two wicks, may be seen in ordinary weather (the horizon of the light, from its elevation above the sea level, being equal to or greater than that distance) at the distance of fifteen to eighteen nautical miles.

The brilliancy of a catadioptric third order larger size apparatus, illuminated by a mechanical lamp of two wicks, consuming one hundred and ninety grammes of oil per hour, (six and three-fourth ounces) has been found equal to seventy burners.

We suppose that it embraces only four-fifths of the horizon. To illuminate, by means of reflectors, the same angular space of 288° , with an *effect of light about equal*, fourteen parabolic reflectors, of about eleven inches in diameter, illuminated by Argand lamps, consuming each thirty-five grammes of oil per hour, will be required. The useful effect of these reflectors will be represented by 870,240, and that of the catadioptric apparatus by 1,160,000; and thus it is seen, that notwithstanding the very great difference in favor of the catadioptric apparatus, in the consumption of oil, it is also superior in useful effect to the light with the fourteen parabolic reflectors. Further, the economical effect of the catadioptric apparatus is represented by 6105, and that of the reflector by 1776, or as 1 to 3.44: "that is to say, without estimating the expenditure of oil by *unity of light*, the lenticular light will be nearly three and a half times more advantageous than the reflector light." With regard to the effective expenditure of oil, they will be in the proportion of 190 grammes to 14×35 grammes per hour, or as 1 to 2.6.

The brilliancy of a catadioptric apparatus of the second order, with a mechanical lamp of three concentric wicks, consuming five hundred grammes of oil per hour, has been found equal to two hundred and sixty-four burners. Supposing that it is only required to illuminate three-fourths of the horizon; then, to obtain an effect about equal in angular space of 270° , at least thirty-four parabolic reflectors of about twenty inches in diameter will be required, which will give a useful effect which is represented by 3,525,120, while that of the catadioptric apparatus is represented by 4,120,000. The comparison between the absolute consumption of oil will be equal to 2.86 to 1; and that of the quantity of oil expended by unity of light equal to 3.33 to 1: thus, under this last report, the lenticular apparatus will be three and a third times as advantageous as the catoptric apparatus.

The maximum brilliancy of a revolving light of the second order, with twelve lenses, has been found to be equal to 1184 burners, and its minimum brilliancy equal to one hundred and four burners. To construct a light, with parabolic reflectors, possessing an equal effect, it will require twenty-four with diameters from twenty-two inches to twenty-four inches, arranged on six faces of the revolving frame. In making the comparison, however, for want of precise data as to the lustres of those reflectors, those of about twenty inches diameter will be referred to. It is supposed that the two lights compared are constructed so as to present the same distinguishing features; the maximum lustre of the reflector light will be equal only to 1080 burners, with other disadvantages; for the details of which, reference may be made to M. Fresnel's note No. 1, section two, (hereto annexed.) M. Fresnel remarks, in this connection, "Without pressing further the comparison of the effects of the two kinds of apparatus, we will perceive, without doubt, the evident advantages of the dioptric or lenticular combination, which in fine weather will not present an *absolute eclipse* at a less distance

than from fifteen to eighteen nautical miles. If we now consider the expenditures of oil, we will find, first, that they are as 24×42 is to 500, or as 1 to 2; second, that the economical effects will be as 2469 is to 10,043, or as 1 to 4.07: thus the lenticular apparatus will be four times as advantageous as the reflector apparatus." "Let us remark, before proceeding further, that in employing 24 parabolic reflectors, of about 20 inches diameter, for such an apparatus, we reach the utmost possible limit, without admitting the employment of lanterns of a size beyond all proper bounds; and we may also affirm, that very few of the catoptric lights, considered as lights of the *first order*, equal the lenticular lights of the same character of the second order.

With reference to the first order dioptric lights, M. Fresnel remarks, in his note: "Now, we have found that the total lustre or brilliancy of an apparatus of this kind is equal in all its azimuths to 480 burners of Carcel. But it will be practically impossible to obtain a like effect in the catoptric system, without having recourse to the employment of 36 parabolic reflectors of about 24 inches diameter." "The difficulty becomes still greater, if it be necessary to attain with these reflectors the effect of a revolving lenticular light, with eight large lenses, the lustres or flashes of which exceed 4000 burners of the Carcel lamp."

"Let us limit ourselves, then, without entering into more full details, to the observation, that the *economical effect* of a fixed light of the first order, illuminating three-fourths of the horizon, is to the *economical effect* of a light composed of parabolic reflectors of about twenty inches diameter, as 10,080 to 2469, or as 4.08 to 1: that is to say, that the first will be (as to the expense of the oil only) four times as advantageous as the second."

With regard to lights *varied by flashes or short eclipse lights*, "the catoptric system is not susceptible of producing that combination without great difficulty, which unites to the permanence of fixed lights the advantage of presenting a very decided character." No repairs are required upon the lenticular apparatus. * * * *

The amount necessary to construct and put into operation a "sideral" light for harbor purposes may be stated at 8,150 francs, or about \$1,500; and the annual expense for its maintenance, including interest upon the cost at the rate of five per cent., at 1,207 francs, or about \$225.

The amount necessary for a catadioptric smaller model harbor light may be put down at 9,181 francs, or about \$1,700; and the annual expense for maintenance, including interest of first cost, &c., as above, at 1,259 francs, or about \$235.

The useful effect of the "sideral" light has been found equal to 68,400, and its economical effect represented by 57.

The useful effect of the catadioptric light, illuminating three-fourths of the horizon, has been found equal to 137,700, and its economical effect, after the same manner, is represented by 109. The comparison of these two will, then, be in the proportion of 57 to 109, or as 1 to 1.91. "Then, besides the advantages of a *double lustre*, the catadioptric apparatus, in an economical point of view, is nearly twice as advantageous as the catoptric apparatus."

M. Fresnel remarks: "It is difficult to establish a comparison of a precise kind between the fixed lights of the third order in the old and the new systems, because we cannot obtain with the ordinary parabolic reflectors a passably equal distribution of light, without multiplying those reflectors to

such a number as would require a much greater expenditure of oil than could be allowed for lights of that class." He says further: "I will merely observe that I have every reason to believe, from the indications contained in the table of light-houses of the United States, that among all the lights of that country illuminated by reflectors, the diameters of which do not exceed sixteen English inches, there are very few whose *useful effect* is superior or equal to that of a catadioptric light of the third order larger model."

The amount necessary for establishing a reflecting revolving light with twenty-four parabolic reflectors of about twenty inches diameter, is estimated at 73,000 francs, or about \$13,700.

Annual expense for maintenance of the same, including interest at five per cent. per annum, will be 8,650 francs, or about \$1,625.

The amount necessary for establishing a second order revolving lenticular light is estimated at 105,500 francs, or about \$19,800.

The annual expense for maintenance of the same, including interest at five per cent. per annum, will be 11,075 francs, or about \$2,075.

The useful effect of the reflector light is represented by 2,488,320, and its economical effect by 288.

The useful effect of the lenticular light is represented by 5,021,467, and its economical effect by 453.

The economical effect of these two lights will then be represented by 288 and 453, or in the proportion of 1 to 1.6. "From whence it results definitively that the lenticular light of the second order will be more than *one and a half times* as advantageous as the catoptric or reflector light, which we may without doubt consider as being of the first order, and the *useful effect* of which, nevertheless, could not be equal to *but half* of the *useful effect* of the former."

No comparison can be entered into between the first order lenticular lights and reflector lights, for the reason that it is impossible to construct a reflector light which would produce a sufficiently powerful effect to be compared to a dioptric one, without increasing the dimensions of the lantern, and the number and size of the reflectors, to a degree which would be attended with a very great expense, and equally great inconvenience.

From the foregoing details, which have been drawn mainly from information furnished by M. Fresnel, the following seems to be but just conclusions:

"1. That the lights fitted with the dioptric apparatus present a variety in their power and effects, and may be made to produce an intensity of lustre, which render them of an interest, in a nautical point of view, incontestably superior to those fitted with the catoptric apparatus.

"2. That if we take into account the first cost of construction and the expense of their maintenance, we will find, with respect to the effect produced, the new system (dioptric) is still from *once and a half* to *twice* as advantageous as the old," (reflector.)

If additional arguments and evidence were wanting to establish the now almost universally conceded fact, of the very positive and decided advantages of the dioptric system of Fresnel over all other modes of illumination for light-houses, they might be found to exist at present in an unanswerable form—that of the practical and successful application of the system, within the last few years, in nearly all the commercial nations of the world. Prior to the year 1832, there was not a single dioptric light out of France; and

on the French coast, at as late a period as 1834, there were but fourteen large and fifteen small, or harbor lights, fitted with the dioptric apparatus.

On the 31st December, 1845, there were belonging to the French light-house department *one hundred and twelve lights* fitted with the dioptric apparatus, and throughout the world not less than *two hundred and ten lights* fitted upon this new system; one hundred of which are of the three first orders, and the remaining one hundred and ten, small or harbor lights, without including apparatus now in course of construction at Paris, to which allusion has already been made.

The objections which have been made by *a few persons* to the employment of the Fresnel dioptric apparatus for the illumination of light-houses, in consequence, as they allege, of the difficulties which attend the management of the mechanical lamps with concentric wicks, (which are absolutely necessary for the proper illumination of the larger orders of apparatus,) seem to be no longer tenable, if indeed there ever were any reasonable grounds of objection on that account.

The twenty-three years' experience in France, (dating from the time the Cordouan light was exhibited,) where *ordinary day laborers are taken for light-keepers*, and the undeniable fact of the successful employment of the system for fourteen years in Holland, Scotland, and Norway; for from five to ten years in England, Sweden, Denmark, Prussia, Belgium, Spain, Sardinia, Tuscany, Naples, Brazils, West Indies, islands of the Pacific ocean, Cape of Good Hope, &c., must be sufficient evidence to convince any disinterested and unprejudiced mind of the utter folly of such an objection at the present day.

In a communication to the government of Norway and Sweden, in 1830, M. Fresnel remarks upon this subject: "Happily, an experience of *seven years* has dissipated that fear, and the lenticular lights have been distinguished up to this time by the regularity of their service." Again, in reference to the same subject, M. Fresnel remarks in a note to the undersigned, that "opinions thus expressed *fifteen years since*, based upon an experience of seven years, have been greatly strengthened up to the present time, embracing a period of *twenty-two years* since the establishment of the Cordouan light, and sustained by the results daily offered of more than one hundred and ten lights of the first three orders, established along the coasts of France and different foreign powers." "In this important point of view, then, the question seems to be irrevocably settled; and I will only add a few considerations relative to the application, more or less extended, which may be made of the new system of illumination to the vast maritime coasts of the United States."

It has been further objected that competent persons could not be procured in the United States to take charge of the lights fitted with the dioptric apparatus and mechanical lamps, for the salaries at present paid to light-keepers of the existing lights. The number of keepers necessary for those lights has also been urged as an objection to their introduction; and there is also a third objection, emanating from the same source, that the mechanical lamps could not be repaired when employed at distant or isolated points on the coast.

With regard to the keepers, no better evidence can be adduced than the opinions of M. Fresnel upon the subject, and the practical results furnished daily, wherever the lights are employed. M. Fresnel says, "that the difficulty of obtaining proper persons to fill these subaltern stations appears

to be most singularly exaggerated." "In France they belong almost always to the class of *ordinary mechanics or laborers*, who make from one and a half to two and half francs per day, (from 27 to 46 cents.") "Eight or ten days will suffice, ordinarily, to instruct a light-house keeper in the most essential parts of his duty, receiving lessons from an instructor conversant with all the details of the service; and two instructing officers will be sufficient to prepare keepers for all the lenticular lights which could be successively established upon the coasts of North America." "In defence of this assertion, I will cite the example of the administration of Norway and Sweden."

As to the number of keepers allowed to the dioptric lights, there might be some reason in the objection, if it were possible to produce a light with parabolic reflectors possessing in any reasonable degree the advantages arising from the employment of a first order catadioptric apparatus; but as it is well established that reflectors are not susceptible (practically) of any combination which would produce a light equal in every respect to a first order dioptric light, the objection ought in honesty to be abandoned or waived by them, without they prefer bad to good lights, to guide the mariner in his perilous way along our shores.

The lower orders of dioptric apparatus, illuminated by ordinary Argand lamps and burners, with single and double wicks, require but one keeper; and they produce a light far superior to those of the same class in the catoptric system, independently of the economy in the use of the dioptric lights. In Scotland and in England, where the lights are as well if not better attended than in any other parts of the world, the same number of keepers are allowed for the same class of lights, without regard to the apparatus employed, whether catoptric or dioptric. At the South Foreland, for example, there are only three keepers for a first order dioptric and a first order reflector light, placed about three hundred yards apart; and at St. Catherine's a first order dioptric light has but two keepers to attend it; besides, other instances might be cited, if it were deemed at all necessary. But to accomplish in the most perfect manner possible, the great and important objects for which lights are established upon seacoasts, it would seem but reasonable, and certainly desirable, rather to increase the number of keepers ordinarily allowed to catoptric lights, than to diminish the number (taking France as a basis) for those fitted with dioptric apparatus.

In regard to the repairing of the mechanical lamps, it may be asserted, without the fear of being controverted, that in consequence of the superior manner in which these lamps are at present constructed in Paris, they will perform well for a number of years by bestowing upon them only the ordinary attention necessary to keep them clean; besides, the number supplied to each light-house (from 3 to 4, and never less than 3) is a sufficient guarantee against any accidents which could prevent the proper exhibition of the lights. The same objections might, with equal propriety, be urged against revolving, flashing, or any other lights requiring clock machinery; yet such lights are found on every coast where lights exist to any extent. A simple inspection of the works of a mechanical lamp, will convince any person of common understanding, that any mechanic who is capable of repairing the machinery for a revolving light is equally competent to put in order any lamp used in light-houses, and particularly those known as mechanical lamps with concentric wicks.

The oil of colza is used exclusively in the French light-houses. M. Fres-

nel says: "From numerous experiments, it seems to me that these two oils (spermaceti and colza) may be employed with equal success *in lamps of single or multiple wicks.*"

M. Fresnel's preference for the colza (to the sperm oil) is based upon two reasons: first, the colza is less expensive in France than sperm, owing to the fact that the vegetable from which this oil is expressed, is cultivated on a very extended scale in France, Belgium, Holland, Holstein, &c.; and, secondly, the great difficulty in detecting impositions which may be and are practised by mixing inferior oils with the sperm, while, on the other hand, any impurities in the colza are very readily detected. No experiments have yet been made in France to test fully which of the two kinds of oil will produce the best light for light-house purposes.

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There is but one floating-light in France; that is constructed of wood, moored and illuminated after the manner, with a few exceptions, of those belonging to the Trinity board in England. The exceptions are, first; bronze is used in the construction of the lantern in the place of iron; and, secondly; the lamps are mechanical, the pumps of which are put in play by springs, instead of the ordinary fountain lamp. This latter, in spite of the delicate machinery of the lamp, is deemed a very decided improvement, as fulfilling much more fully the requirements of such a lamp, by preserving the centre of gravity in the same vertical during the whole time of the combustion.

HOLLAND.

Ventilation tubes are used in all the lanterns to conduct off the smoke and gasses from the burners. There are ventilators in the floor and sides of the lanterns, which are opened and shut as circumstances require.

The general opinion is, that the dioptric system of Fresnel is preferable to the catoptric one, for the reasons—1st, the superior quality and intensity of the light; 2d, economy in the maintainance when a great arc of or the whole horizon is required to be illuminated; 3d, the variation which can be given to the revolving lights to distinguish the one from the other, by means of determined eclipses, either short or long, or alternated with flashes, and remaining at the same time fixed, visible at shorter distances.

The large number of officers who are constantly employed by the Netherlands government in examining the condition of the dikes, &c., on the seacoasts, affords ample means for discovering any want of efficiency in the lights, or attention to the duties devolving upon those in charge of them.

DANISH LIGHT-HOUSES.

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A due regard is had to the ventilation of the lanterns, to prevent smoke, insure a proper combustion of the oil, and a pure atmosphere for the keepers to breathe, which latter has been of the greatest importance in preserving the health of those whose duty requires them to spend several hours of each night in an atmosphere which, without that precaution, must be

come injurious to health, to say nothing of other ill effects, such as producing an inferior light, &c.

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Both the catoptric and dioptric systems are in use at present in Denmark. Prior to 1842 the catoptric system only was used; but since that period *seven dioptric and catadioptric lights* have been established, which are highly approved of.

The lenticular apparatus were all made in Paris by Mr. Henry Lepaute, under the inspection of M. Fresnel, the engineer-inspector, secretary to the Commission des Phares of France, and put up in their respective towers by native Danes, who had had the opportunity of seeing similar apparatus put up in Norwegian light-houses.

NORWEGIAN, SWEDISH, AND RUSSIAN LIGHT-HOUSE ESTABLISHMENTS.

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In 1830, the government of Norway and Sweden addressed a communication to the French light-house commission upon the subject of the improvement of its lights. In 1832, the light-house at the Isle of Oxöe, was fitted with a dioptric apparatus, the manufacture of Monsieur Soleil, senr., of Paris, under the inspection of M. Leoner Fresnel.

The next dioptric apparatus for that coast was furnished by the same distinguished French artist in 1836, and placed in the tower at *Gunarsborg*. Since that period, dioptric apparatus have been annually introduced into the light-houses of Norway; and, at the present time, there are not less than fourteen or fifteen of the different orders. These lights were fitted up by French mechanics, and the Norwegian keepers who were instructed in the management of the French mechanical lamp with concentric wicks. All lights of this description are now fitted up and attended to, exclusively by *natives of the country*; and it has been reported that no difficulties have been encountered in any of the details relating to their management which required foreign aid.

The rape-seed or colza oil is employed in these lights. The usual means are employed for keeping the oil in a limpid state during the cold weather, (stoves and frost lamps.)

PRUSSIAN LIGHT-HOUSES.

Of the eleven Prussian light-houses at present in operation, two only are fitted with the lenticular apparatus of Fresnel of the second order, which were constructed in Paris. The nine remaining lights are fitted with reflectors. Sufficient time has not elapsed, since the introduction of the lens lights, for the authorities charged with their management to form an opinion as to their superiority to the reflectors; yet they are satisfied, from the reports of those familiar with them, that they are greatly superior to any other apparatus for light-house purposes.

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CHARACTER OF THE FRENCH LIGHTS.

Next to the necessity for visibility at a greater or lesser distance, lights ought, as far as possible, to present characteristic appearances by which to distinguish them not only from the fixed lights which may be visible in the same horizon, but also from lights situated within the limits of any reasonable errors that might be committed by navigators. That announcement would seem to render it necessary to discard the *fixed white lights*. However, as the revolving lights allow of but a small number of sufficiently marked characteristics; and, moreover, as the fixed lights are ordinarily sufficiently distinguished by their elevation, and their greater brilliancy of light than those serving for the illumination of the interior of dwellings and of harbors, we have introduced this description of light, in a greater or smaller proportion, into the whole system of lighting the seacoasts.

We sometimes have recourse to *double fixed lights*, for the purpose of giving to them a very decided character: for example, the two lights of La Hève, near the port of Havre, and the two large lights which are in the course of construction at this time on the left bank of the *Canche*, in the department of the Pas de Calais, without speaking of the double small lights which serve to mark the direction of the channels leading to ports or roadsteads.

Fixed red lights (colored by the application of red glasses) are doubly objectionable: first, because of the very great absorption of the rays of light emitted from the focus; and, secondly, they afford only a doubtful character to the light during the existence of *fogs, when all lights assume a reddish tint*. This mode of distinction has not been employed on the coast of France, except as an accessory, and then only for some small lights situated at the entrances of harbors, for the purpose of varying the appearance of some changing light.

Revolving catoptric, or reflecting lights, are distinguishable generally only by the greater or lesser duration of their *eclipses*, which become *positive* often at the distance of two or three nautical miles.

This mode of distinction, which would seem at the first instant to offer a great variety of combinations, is in reality a very limited one. On one side we cannot extend the interval of time between two consecutive eclipses to three minutes, without prolonging beyond proper limits the duration of the eclipse, during which time the navigator finds himself deprived of his point of recognition; and, on another side, experience proves to us that the difference of thirty seconds may frequently escape an inattentive observer, or one who, in boisterous weather, becomes alarmed at his supposed dangerous situation.

The inconvenience arising from the duration of the eclipses is scarcely perceptible with the revolving dioptric apparatus upon the new model, the fixed accessory parts of which reflect a light constantly visible in a horizon extending to the distance of nine or ten nautical miles with an apparatus of the second order, and with those of the first order to twelve or fifteen nautical miles.

The different combinations of changeable dioptric lights at present established are as follows:

First, flashes which succeed each other every minute.

Secondly, flashes which succeed each other every half minute.

Thirdly, alternate white and red flashes.

Fourthly, fixed light, varied by flashes once in every four minutes.

Fifthly, fixed light, varied by flashes once in every three minutes.

Sixthly, fixed light, varied by flashes once in every two minutes.

Seventhly, fixed white light, varied by red flashes more or less frequent.

These make a total of nine principal combinations. It is proper to remark, besides, that the three first combinations have been applied only to the first three orders of lights, conceiving that in the inferior orders the flashes would have too short a duration, and that the eclipses do not cease to be positive, but at too short a distance from the light-house, in consequence of the feebleness of the fixed subsidiary portion of the apparatus.

USEFUL AND ECONOMICAL EFFECTS OF THE DIFFERENT LIGHTS.

The useful effect of a light-house apparatus is measured by the quantity of light which it projects upon the horizon.

Observations of *range* for that purpose furnish but very uncertain evidence, on account of the difficulty of ascertaining the *absolute range* of a light, which varies according to the state of the atmosphere, and according to the good or bad sight of the observer.

To arrive at, and to establish, in this connexion, true parallel valuations, it is indispensable to have recourse to photometric experiments. For that purpose, having taken a *model lamp for unity of light*, (the ordinary lamp of Carcel, for example,) receive upon a screen fixed at a proper distance the two shadows projected by the same *style*, which is illuminated at the time by the apparatus to be measured, and by the *lamp of unity*. The latter, placed upon a movable stand or table, is moved nearer to or further from the screen, until the two adjacent shadows appear of an equal intensity, and the squares of the distances of the two luminous bodies to the screen will be to each other as the intensities of their lights.

To measure the *total useful effect* of a parabolic reflector, or of a plano-convex lens, we may proceed in the following manner: After having placed the apparatus in the centre of a revolving stand or table, fitted with a movable needle and a graduated circle, measure the intensity of the light in different azimuths upon the whole horizontal extent of the luminous cone; take the mean corresponding to each angular extent; multiply that mean by the number of divisions of the arc, and the sum of all these partial products will represent the *total useful effect*. The *mean brilliancy* of the illuminated sector answers, moreover, to the quotient of the useful effect, divided by the arc which measures the amplitude of that sector.

We will find, lastly, the quantity of oil expended *by unity of light, and per hour*, in dividing the total useful effect by the number of grammes of oil consumed in an hour, and the quotient will represent the *economical effect*.*

Photometric measures taken in this manner in the whole illuminated angular extent of a revolving apparatus, make known the *maxima and minima* intensity of its flashes, and from which we determine the *duration*

* Whenever the *economical effect* of two lights is to be compared, it is not sufficient to take simply the expenses of the oil. It will be necessary to estimate their annual expense, and divide it by the amount of light usefully expanded upon the horizon, in the manner hereafter described.

of their apparitions, by dividing by the entire circumference the product of the illuminated arc, multiplied by the duration of a revolution.

If it be required to construct with parabolic reflectors an apparatus for a fixed light to illuminate a given angular extent, we must first determine, by photometric results, the number of reflectors necessary to distribute in the extent to be illuminated—if not uniformly, at least in a complete manner.

Finally, if the catoptric apparatus is to be revolving, it is easily ascertained what number of reflectors are to be placed in the same plane upon each face of the movable frame, to obtain the total brilliancy necessary.

Useful and economical effect of the catoptric apparatus.

Catoptric lights are so varied in their dimensions, and their reflecting powers at the same time so variable, according to the degree of perfection in their fabrication, (without adverting to the differences in the calibres of the lamp burners,) that it will be very difficult to present, with any degree of certainty, the table of *useful effects* to the principal lights of that system at present in use on the coasts of England, the United States, and of France.

I will limit myself here to some indications relative to lights of this description, which I have at my disposition. I will remark, once for all, that the *unity of light* to which all the photometric results which may be given hereafter have been referred, is the ordinary burner of a Carcel lamp, burning 42 grammes (1 oz. 7.73 drachms) of the oil of colza per hour.

(A.)—Photophore (reflector) with an aperture of 50 centimetres, (19.69 inches,) and a depth of 20 centimetres, (7.876 inches,) illuminated by a lamp burning 42 grammes (1 oz. 7.73 drachms avoirdupois) per hour of oil.

Azimuths.	Brilliancy or lustre.		Observations.
	Corresponding to the divisions—	Means.	
	<i>In burners.</i>	<i>In burners.</i>	
10°	2	10	The brilliancies or lustres measured at equal distances to the right and to the left of the axis have presented differences sufficiently remarkable; but uniformity has been established by taking the means. No account has been taken of the brilliancy of the simple burner beyond 10°; so that the amplitude of the luminous cone has been computed as reduced to 20°.
8°	18	31	
6°	44	59	
4°	74	117	
2°	160	215	
0°	270	215	
2°	160	117	
4°	74	59	
6°	44	31	
8°	18	10	
10°	2	10	
		864	This sum represents the <i>useful effect</i> for the uniform divisions of every 20°.

Useful effect, corresponding (as is ordinarily done) to the division of the circle into minutes, in this case = $864 \text{ burners} \times 120' = 103,680$.

Mean lustre or brilliancy $= \frac{864}{10} = 86.4$ burners.

Maximum lustre or brilliancy corresponding to the axis $= 270$ burners.

Economical effect $= \frac{103,680}{42 \text{ grammes}} = 2,469.$

(B.)—Photophore (reflector) with an aperture of 0.275 metre, (10.83 inches,) and a depth of 12 centimetres, (4.72 inches,) illuminated by a lamp burning 35 grammes (1 oz. 3.75 drachms) of oil per hour.

Azimuths.	Brilliancy or lustre.		Angular distance.	Products.	Observations.
	Corresponding to the divisions—	Means.			
	<i>Burners.</i>	<i>Burners.</i>			
16°	2	3	1°	3	As the divisions are unequal, it has been found necessary to multiply each mean lustre or brilliancy by the angular space corresponding to it.
15°	4	5	1°	5	
14°	6	9	2°	18	
12°	12	15	2°	30	
10°	18	22.5	2°	45	
8°	27	37.5	2°	75	
6°	48	57	2°	75	
0°	66		6°	342	
				518	

Useful effect, corresponding to the division in minutes, in this instance, is $= 2 \times 518 \times 60' = 62,160.$

Mean lustre or brilliancy $= \frac{518}{16} = 32.4$ burners.

Maximum lustre or brilliancy corresponding to the axis $= 66$ burners.

Economical effect $= \frac{62,160}{35} \text{ grammes} = 1,776.$

(C.)—"Sideral" reflector of Bordier Marcet, formed of two parabolic metallic mirrors, with a diameter of 0.344 metre, (13.54 inches,) and an aperture of 0.187 metre, (7.364 inches,) illuminated by a lamp burning 50 grammes (1 oz. 12.25 drachms avoirdupois) of oil per hour.

Uniform brilliancy or lustre in all the azimuths $= 4$ burners. The extent illuminated, after deducting the spaces occupied by the lamp and the frame, is about 285 degrees, or 17,100 minutes.

Useful effect $= 4 \times 17,100 = 68,400.$

Economical effect $= \frac{68,400}{50} = 1,368.$

The foregoing results confirm the following principles, the evidence of which springs moreover from a simple enunciation of them :

1st. *The useful effect* of a parabolic reflector increases with its dimensions, and with that of the illuminating body.

2d. *The economical effect* of a reflector of given dimensions is greatest when the lamp-burner is smallest.

3d. *The divergence* is greatest when the flame is most voluminous, or when the reflector is smallest. We cannot, then, (all other things being equal,) augment the *economical effect* of a reflector, without diminishing its *useful effect*—that is to say, without reducing its brilliancy or intensity, and consequently its range. The reduction of the volume of light within certain limits is particularly objectionable when it appertains to eclipse apparatus, in which case it limits the width of the luminous cone, and consequently augments the length of the eclipses.* The same reduction applied to the crowns (foci) of reflectors composing a fixed light apparatus, may weaken the light in their intervals to such a degree as to produce *dead angles*, or become completely obscured to the observer beyond certain distances.

It is further proper to remark that the horizontal divergence is not lost for *useful effect*, but that the divergence in the vertical sense only profits the navigator in the limited angular space comprised between the tangent at the surface of the sea, and the ray terminating at the distance of some miles from the light.

Finally, there is for the calibre of the lamp-burners applicable to reflectors of given dimensions, and destined for the illumination of an equally determined range, a *maximum* beyond which prodigality of light ensues, and a *minimum* within which the illumination becomes insufficient.

Useful and economical effect of dioptric apparatus.

Before commencing an analysis of the effect of the light of the lenticular or dioptric apparatus, I will state—

First. That these lenses always contain, independently of the fixed or movable dioptric drum, a *subsidiary catoptric* or *catadioptric part*, the *useful effect* of which is combined with that of the *principal part*.

Second. That when these lenses are not required to illuminate the whole of the horizon, that side which remains deprived of light is fitted with spherical reflectors (metallic) in place of the dioptric drum, which adds about *one-fifth* to the intensity of the sector directly corresponding.

That being stated, I now proceed to present the photometric results obtained from different lenses of the four orders of dioptric apparatus.

[Lenticular apparatus of the first order.]

(A)—*First order lenticular apparatus for a fixed light, with accessory catoptric part.*†

Lustre or brilliancy of the dioptric drum = 360 burners.

* It was to obviate the defect of divergence that Bordier Marcet invented his large double parabolic reflectors with double focus; but that combination caused too great a loss of light.

† Notwithstanding the decided advantages which the catadioptric zones present, compared to the mirrors, we may, by reason of their economy, prefer, under some circumstances, the second combination to the first for lenticular apparatus of the *first order*.

Mean brilliancy of mirrors—

$$\left. \begin{array}{l} 7 \text{ upper zones} = 80 \\ 4 \text{ lower zones} = 40 \end{array} \right\} = 120 \text{ burners.}$$

$$\text{Total amount of brilliancy} = \underline{\underline{480}} \quad "$$

Calculation of the useful effect.

1st. The dioptric drum illuminating equally the whole of the horizon, (except about 26° , being computed the amount of space occupied by the frames of the apparatus, and that of the lantern,) = $360 \text{ burners} \times 20,000' =$ - 7,200,000

2d. 7 zones of upper mirrors = $80 \text{ burners} \times 20,000' =$ - 1,600,000

3d. 4 zones of lower mirrors, omitted for one-eighth of the circumference, for the necessary passage of the keepers, = $40 \text{ burners} \times 17,500' =$ - - - 700,000

Total of useful effect - - - 9,500,000

$$\text{Economical effect} = \frac{9,500,000}{750} \text{ grammes} = 12,667.$$

If the apparatus illuminate only three-fourths of the circumference of the horizon, the useful effect will be reduced to - 7,200,000

To which must be added the effect of the reflector occupying the vacant space in the dioptric drum, one-fifth ($360 \text{ burners} \times 5,000' =$ - - - 360,000

Useful effect of the apparatus, for $270^\circ =$ - - - 7,560,000

$$\text{1st order, economical effect} = \frac{7,560,000}{750} \text{ grammes} = 10,080.$$

(a¹)—*First order lenticular apparatus for a fixed light, with accessory catadioptric part.*

Lustre or brilliancy of the dioptric drum - - - 360 burners.

Cupola or upper zones = - - - 140 burners } 200 "

Lower zones - - - 60 " } 200 "

Total brilliancy - - - 560 "

Calculation of the useful effect.

$560 \text{ burners} \times 20,000' =$ - - - 11,200,000

From which must be deducted for the passage of the keepers,

$60 \text{ burners} \times 2,500' =$ - - - 150,000

Remainder of useful effect = - - - 11,050,000

$$\text{Economical effect} = \frac{11,050,000}{750} \text{ grammes} = 14,733.$$

If the apparatus illuminate only three-fourths of the circumference of the horizon, the useful effect becomes reduced to

$$560 \text{ burners} \times 15,000' = - - - - - 8,400,000$$

To which must be added, as in the other case, for the advantages of the reflector occupying the open space in the dioptric drum, one fifth ($360 \text{ burners} \times 5,000'$) = - - - 360,000

$$\text{Useful effect of the apparatus, for } 270^\circ - - - - - \underline{\underline{8,760,000}}$$

$$\text{Economical effect} = \frac{8,760,000}{720} \text{ grammes} = 11,680.$$

(a²)—*First order revolving lenticular apparatus, with accessory catoptric part.*

Brilliancy or lustres, measured upon one-half of the amplitude of the luminous beam, emitted from a lens of one metre (39.38 inches) in height, and occupying a space of 45° :

Azimuths.	Brilliancy or lustre.		Observations.
	Answering to the divisions.	Means.	
	<i>Burners.</i>	<i>Burners.</i>	
210'	4 (?)	77	The annexed brilliances of light are the results of means of different experiments. It is just to remark, that all the divisions have intervals of thirty minutes, so as to distribute, in effect, the partial products of the mean intensities into the angular distances.
180'	150	475	
150'	800	1,400	
120'	2,000	2,450	
90'	2,900	3,300	
60'	3,700	3,800	
30'	3,900	4,050	
0'	4,200		
		15,552	

$$\text{The useful effect of a lens} = 2 \times 15,552 \times 30' = - - - \underline{\underline{933,120}}$$

$$\text{Ditto of the 8 lenses of a dioptric drum} - - - - - *7,464,960$$

$$\text{Ditto of 11 zones of mirrors, as before} - - - - - \underline{\underline{2,300,000}}$$

$$\text{Total useful effect} - - - - - \underline{\underline{9,764,960}}$$

$$\text{Economical effect} = \frac{9,764,960}{750} \text{ grammes} = - - - - - 13,020$$

$$\text{If the apparatus illuminate only three-fourths of the horizon, the useful effect will be reduced to} = - - - - - \underline{\underline{7,758,720}}$$

$$\text{And the economical effect to} = - - - - - \underline{\underline{10,345}}$$

* We have given 7,200,000 to the dioptric drum of a *fixed light*—an amount which seems satisfactory, in consideration of the degree of uncertainty attending photometric operations.

(b)—*Second order lenticular apparatus for a fixed light, with a catadioptric accessory part.**

Lustre or brilliancy of the dioptric drum =	-	-	160 burners.
Upper part, or cupola =	-	-	76 burners.
Lustre or brilliancy of the catadioptric zones—lower zones =	-	28	104
			—
Total lustre or brilliancy in burners	-	-	264
			—

Calculation of useful effect.

264 burners $\times$ 20,000'	-	-	-	5,280,000
From which must be deducted for the space of one-sixth of the circumference, which is not supplied with the catadioptric zones below the lenticular drum =	-	-	-	93,333
				—
Remainder of the useful effect =	-	-	-	5,186,667
				—
Economical effect =	5,186,667			
	500	grammes =	-	-
			-	10,373
				—

If the apparatus illuminate only five-sixths of the circumference of the horizon, a reflector is placed on the side of the earth; the useful effect then becomes reduced to 4,706,667, and the economical effect to 9,413.

For an illumination embracing only three-fourths of the circumference of the horizon, the useful effect is then reduced to 4,120,000, and the economical effect to 8,240.

(b¹)—*Second order revolving lenticular apparatus, with catadioptric accessory part.*

The lustres or brilliancies measured upon half of the amplitude of the luminous beam emitted from a lens of 80 centimetres in height, occupying a space of 30 degrees.

Azimuths.	Brilliancy or lustre.		Angular distances.	Products.	Observations.
	Answering to the divisions.	Means.			
	<i>Burners.</i>				
210'	3 (?)	32 (?)	30'	960	
180'	61	167.5	30'	5,025	
150'	274	383	30'	11,490	
120'	492	699.5	30'	20,985	
90'	907	920	30'	27,600	
60'	933	1,006.5	30'	60,390	
0'	1,080		60'		
				126,450	

* For the second order (and with greater reason for the inferior orders) we dispense with the use of the *concave mirrors* for the subsidiary part of the apparatus. The increased useful effect of that part which is *always fixed* is, above all, important in the revolving dioptric drum apparatus to prevent, at a certain distance, the complete disappearance of the light or positive eclipses.

Useful effect of a lens $2 \times 126,450 =$ - - - 252,900

Useful effect for 12 lenses of the drum - - - 3,034,800

Useful effect for catadioptric zones - - - 1,986,667

Total useful effect = - - - 5,021,467

Economical effect = $\frac{5,021,467}{500}$ grammes = - - - 10,043

(c)—*Lenticular apparatus for a fixed light of the third order (larger size) with catadioptric accessory part.*

Brilliancy of the dioptric drum = - - - 50 burners.

Brilliancy of the catadioptric dome or cupola = - - - 20 “

70 “

Useful effect = 70 burners $\times 20,000' =$ - - - 1,400,000

Economical effect = $\frac{1,400,000}{190}$ grammes = - - - 7,368

If the apparatus illuminate only four-fifths of the circumference of the horizon, the useful effect is reduced to - - - 1,120,000

To which add for spherical reflector - - - 40,000

Total useful effect = - - - 1,160,000

Economical effect = $\frac{1,160,000}{190}$ grammes = - - - 6,105

Catadioptric apparatus of the third order (smaller size) for a fixed light.

Brilliancy of the apparatus = 31 burners.

Useful effect = 31 burners $\times 20,400' =$ - - - 632,400

Economical effect = $\frac{632,400}{115}$ grammes = - - - 5,4999

If the apparatus illuminate only three-fourths of the circumference of the horizon, the *useful effect* will be reduced to 474,300, and the economical effect to 124.

It must be remembered that this apparatus may be illuminated with a decided advantage by means of an *ordinary Argand lamp with one wick*, with which we will obtain the following results :

Brilliancy of the apparatus = 25 burners.*

Useful effect $25 \times 20,400' =$ - - - - - 510,000

Economical effect = $\frac{510,000}{60}$ grammes = - - - - - 8,500

Fourth order catadioptric apparatus for a fixed light (larger model.)

Brilliancy of the apparatus = 15 burners.

Useful effect = $15 \times 20,400' =$ - - - - - 306,000

Economical effect = $\frac{306,000}{60}$ grammes = - - - - - 5,100

If the apparatus illuminate only three-fourths of the horizon, the useful effect will become reduced to 229,500, and the economical effect to 3,825.

Fourth order catadioptric apparatus (smaller model) for a fixed light.

Brilliancy of the apparatus = 9 burners.

Useful effect = $9 \times 20,400' =$ - - - - - 183,600

Economical effect = $\frac{183,600}{45}$ grammes = - - - - - 4,080

If the apparatus illuminate only three-fourths of the circumference of the horizon, the *useful* effect becomes reduced to 137,700, and the economical effect to 3,060.

General observations upon photometric measures.

The photometric results from which I have deduced the values of the *useful effects* and of the *economical effects* of the various orders of *catoptric* and *dioptric* apparatus should only be considered as simple approximations. New experiments upon apparatus of the same kind would show, without doubt, very remarkable differences, not only because of the greater or lesser precision which the construction of the optical pieces may present, and of the difficulty of obtaining the identity of brilliancy in the *unity of light*, but also in consequence of the nature of the photometric experiments, where it becomes necessary to estimate by *the eye* the equal intensities of shadows produced by light, often of different tints.

These approximations are always sufficient to establish results exact enough between the effects of the different illuminating apparatus to be compared, and give much more correct ideas as to their relative values than can be deduced from observations upon the *absolute range* of the lights.

* The catadioptric apparatus of 50c. (19.69 inches) diameter, illuminated thus by an ordinary constant level lamp, burning 60 grammes (2 ounces 1.9 drachm avoirdupois) of oil per hour, offers a very advantageous combination for the illumination of the entrances to ports and roadsteads, with ranges of 12 to 15 nautical miles. *One keeper is sufficient to perform with ease all the service; and the ordinary annual expense does not exceed (in France) one thousand, to eleven hundred francs (\$187 50 to \$206 25.)*

Service of the catoptric lights.

The *fixed catoptric lights* established upon *land*, and illuminated by a small number of reflectors, say from six to eight, may be attended by a single keeper, especially if he be assisted by his family. If the apparatus be a revolving one, or if the number of reflectors be greater than six or eight, it will become, ordinarily, necessary to employ two keepers, as well to superintend the light during the night, as to maintain in a proper manner the illuminating apparatus and fixtures. If the light be placed in an isolated position at sea, three keepers at the least are necessary to assure regular attendance. In such cases, these agents (keepers) are relieved at regular intervals, and permitted to return to the Continent for fifteen days or a month.

Service of the lenticular lights.

The lenticular lights of the fourth order, and of the third order smaller model, require but a single keeper to superintend them, except in cases when situated at isolated points at sea.

Two keepers are required to superintend the lights of the third order larger model, and the second order, in consequence of the use of the mechanical lamps in those lights.

Three keepers are required for the superintendence of lights of the first order.

For lights of the second and third orders, in isolated positions at sea, it is necessary to employ *three keepers*, and *four keepers* for lights of the first order similarly situated.

COMPARISON OF THE TWO SYSTEMS OF LIGHTS.

[Parallel between the catoptric and dioptric lights.]

The preceding developments have appeared to me indispensable, as preliminaries to the establishment of a parallel between the two systems of illuminating light-houses.

I will consider the two systems under the following heads:

- 1st. The *absolute useful and economical effects*.
- 2d. The *first cost of the establishment*, and of *the repairs and maintenance*.
- 3d. The *facility and safety* of the service.

[Apparatus of the fourth order, smaller model.]

SEC. 1. *Absolute useful and economical effect of the illuminating apparatus.*—The *brilliancy* of a *catadioptric apparatus* of 30c. (11.8 inches) interior diameter, illuminated by a lamp burning 45 grammes (*one ounce nine and four-tenths drachms avoirdupois*) of oil per hour, has been found to be equal to eight or nine burners.

The *brilliancy* of a "*sideral*" reflector, illuminated by a lamp burning 50 grammes (*one ounce twelve and twenty-five hundredths drachms avoirdupois*) of oil per hour, is equal to four burners. This brilliancy of the first is at least *double* that of the second.

The *useful effect* of the *catadioptric apparatus* of the fourth order, illuminating three-fourths of the circumference of the horizon, is represented by 137,700. The *useful effect* of the "*sideral*" reflector is equivalent to 68,400. Comparison of the second to the first = 1 to 2. Economical effect of the catadioptric apparatus = 3060. Economical effect of the "*sideral*" reflector = 1368. Comparison of the second to the first = 1 to 2.24. If we take for a term of comparison the ordinary reflector, (*à coquille plate.*) the superiority of the catadioptric apparatus will be still more decided. With regard to the *concave parabolic reflectors*, or "*photophores*," I will not introduce them into this parallel, in consideration that they can only serve in isolated cases for the ordinary illumination of the entrances to harbors, upon an amplitude of not more twenty degrees.

[Apparatus of the third order, smaller model.]

The apparatus of the third order, smaller size, illuminated by an ordinary *fountain, or constant level lamp*, carrying one burner and one wick, consuming 60 grammes (*two ounces one and nine-tenths drachm avoirdupois*) of oil per hour, or one burner with *two wicks*, consuming 115 grammes (*four ounces and one drachm*) of oil per hour, have no equivalents in the *catoptric apparatus* in use at present.

A "*sideral*" apparatus, of the same useful effect, would be of a dimension which would render the construction of it very difficult, and very expensive, and would require, relatively, a very great consumption of oil. Neither could we supply it in a proper manner, by the use of parabolic reflectors, except they were made expressly for the purpose, of very small dimensions, to allow a sufficient number to distribute properly the light upon three-fourths of the horizon. It is evident, moreover, that, that embarrassing combination would require a consumption of more than 200 grammes (7 ounces) of oil per hour.

The old light of Cette, (Herault) provisionally illuminated by a catadioptric apparatus of 50 centimetres (19.69 inches) diameter, with a lamp of two concentric wicks, is easily seen, in ordinary weather, at the distance of 15 to 18 nautical miles, although it is given a *range* in the official table of only 12 nautical miles.

[Apparatus of the third order, larger model.]

The brilliancy of catadioptric apparatus of the third order, one metre (39.38 inches) in diameter in the interior, illuminated by a mechanical lamp of double wick, burning 190 grammes (6 oz. 11.35 drachms) of oil per hour, has been found = 70 burners. I will suppose, moreover, that it embraces only four-fifths of the horizon.

To illuminate, by means of reflectors, the same angular space of 288° , with an effect of light *about equal*, it will be necessary to employ 14 parabolic reflectors (*photophores*) of 57.5c. (10.8 inches) diameter, each burning 35 grammes (1 oz. 3.8 drachms) of oil per hour. The brilliancy

in the axis of each of the 14 reflectors will be about $= 66$ burners. The brilliancy in the intervals, the least illuminated, will be $= 36$ burners. The useful effect will be represented by $14 \times 62,160 = 870,240$. But the useful effect of the catadioptric apparatus has been found to be $= 1160,000$. In this case, notwithstanding the very great difference in the consumption of oil, the dioptric or lenticular apparatus is superior, in useful effect, to the catoptric apparatus. The economical effect of the first apparatus is represented by 1786: comparison $= 1$ to 3.44; that is to say, without estimating the expenditure of oil by *unity of light*, the lenticular apparatus will be nearly three and a half times more advantageous than the catoptric apparatus. With regard to the effective expenditure of oil, they will be in the proportion of 190 grammes to 14×35 grammes, or of 1 to 2.6.

[Apparatus for a fixed light, second order.]

The brilliancy of a catadioptric apparatus of the second order, having an interior diameter of 1m. 40c. (4 feet 7.13 inches,) illuminated by a mechanical lamp of three concentric wicks, burning five hundred grammes (17 oz. 10.5 drachms) of oil per hour, has been found to be $= 264$ burners. Let us suppose it only embraces three-fourths of the horizon. To obtain an effect about equal in an angular space of 270° , it will be necessary to employ at least thirty-four parabolic reflectors, having fifty centimetres (19.69 inches) diameter. The brilliancy in the axis of each of these thirty-four reflectors will be $= 270$ burners. But the lustres in the intervals are only $= 148$ burners. The useful effect of the catadioptric apparatus will be 4,120,000, and that of the thirty-four reflectors by $34 \times 103,680 = 3,525,120$. The comparison between the absolute expenditure of oil will be

$$= \frac{34 \times 42}{500} = 2.86 \text{ to } 1;$$
 and the comparison of the quantity of oil expended by unity of light $= \frac{2469}{8240} = 1 \text{ to } 3.33$; thus, in this last respect, the lenticular apparatus will be three and one-third times as advantageous as the catoptric apparatus.

[Revolving apparatus of the second order.]

The *maximum brilliancy* or lustre of the revolving apparatus of the second order, with twelve lenses, has been found to be $= 1,184$ burners, as follows:

1st. Brilliancy in the axis of a lens	$=$	-	-	-	-	1,080	burners.
2d. Brilliancy in the fixed catadioptric zones	$=$	-	-	-	-	104	"

Total amount of brilliancy	$=$	-	-	-	-	1,184	"
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And the *minimum* corresponding to the eclipses, is equivalent to one hundred and four burners.

To construct a catoptric apparatus, possessing an equivalent effect, without multiplying beyond bounds the reflectors, (photophores,) it will be requisite, without doubt, to take those with diameters of fifty-five centimetres to sixty centimetres (21.66 inches to 23.63 inches;) but for want of sufficiently precise data as to their lustres, I will suppose the employment of reflectors of fifty centimetres (19.69 inches) diameter, which give, in their

axis, a lustre equal to two hundred and seventy burners. I will suppose, also, that the frame has six faces, each fitted with four of these reflectors. I will admit, lastly, as the succession of flashes ought to be the same in both systems, that the lenticular apparatus makes its revolution in six minutes, and the catoptric apparatus in three minutes. The maximum lustre of the catoptric system will be equal to $4 \times 270 = 1,080$ burners. The amplitude of the lustres of the reflectors being, moreover, of sixteen degrees at most, there will be six angles of forty-four degrees each almost entirely obscured; and the length of these eclipses will be twenty-two seconds, while the length of the flashes will be only eight seconds.

Without pressing further the comparison of the effects of the two kinds of apparatus, we will perceive, without doubt, the evident advantages of the dioptric or lenticular combination, which, in fine weather, will not present an *absolute eclipse* at a less distance than fifteen to eighteen nautical miles. If we now consider the expenditure of oil, we will find—

First, that they are as $24 \times 42 : 500$, or :: 1 to 2;

2. That the economical effects will be as $2,460 : 10,043$, or as 1 to 4.07.

Thus the lenticular apparatus will be *four times* as advantageous as the catoptric or reflector apparatus.

I admit that this result might be modified by the employment of larger reflectors; but as their divergence would be less, the length of the flashes would be diminished, and consequently that of the eclipses would be augmented too much.

Let us remark before proceeding further, that in employing 25 parabolic reflectors (photophores) of 50 centimetres (19.69 inches) diameter for such an apparatus, we reach the utmost possible limit, without admitting the employment of lanterns of a size beyond all proper bounds; and we may also affirm that very few of the catoptric lights, considered as lights of the *first order*, equal the lenticular lights of the same character of the *second order*.

[Apparatus of the first order.]

With the view not to multiply unnecessarily the comparisons, I will omit the details relative to the first order of the catadioptric combination, which is the most advantageous; and I will suppose, in consequence, the lenticular apparatus fitted in its accessory part with eleven zones of fixed mirrors. Now, we have found that the total lustre or brilliancy of an apparatus of that kind is equal in all its azimuths to 480 burners. But it will be practically impossible to obtain a like effect in the catoptric system, without having recourse to the employment of 36 reflectors with apertures (diameters) of 60 centimetres (23.63 inches.)

The difficulty becomes still greater if it be necessary to attain with these parabolic reflectors the effect of a revolving lenticular light with eight *large lenses*, the lustres or flashes of which exceed 4,000 burners of the Carcel lamp.

Let us limit ourselves, then, without entering into more full details, to the observation that the *economical effect* of a fixed light of the first order, illuminating three-fourths of the horizon, is to the *economical effect* of a light composed of parabolic reflectors ("photophores") of 50 centimetres (19.69 inches) diameter as 10.080 to 2.469, or as 4.08 to 1. That is to say, that

the first will be (as to the expense of oil only) four times as advantageous as the second.

[Apparatus for lights varied by flashes.]

I will only refer here to the apparatus for *lights varied by flashes*, (otherwise called of *short eclipses*,) for the purpose of remarking that the catoptric or reflector system is not susceptible of producing, without great difficulty, that combination which unites to the permanence of fixed lights the advantage of presenting a very decided character.

SEC. 2. *Expenses of first establishing and of maintaining light-houses.*—So far, I have compared the *economical effects* of the different kinds of apparatus only with reference to the expenditures of oil; but it will not fail to be objected that the advantages which I point out in favor of the lenticular system ought to be very greatly diminished in a fiscal point of view, in consequence of the high price of the apparatus, and the excess of keepers necessary to their service. To appreciate the value of that objection, I will compare several lights of both systems, taking into the account all the expenses to which they could be subjected, and for the first example I will take the harbor lights.

HARBOR LIGHTS.

A harbor light, placed at the entrance to a port, being often exposed to the force of the sea, ought (to insure proper attendance, &c.) to be erected securely in a bronze lantern, fitted upon the summit of a small tower constructed of masonry, and sufficiently spacious for the purposes of illumination and attendance at all times, and in every description of weather.

That being established, we may state the expenses for first establishing for both systems, (in France,) as follows:

1. *Small "sideral" light.*

Small tower in masonry	-	-	-	-	5,000 fr.
Octagonal lantern, 1m. 40c. (4 feet 7.13 inches) in diameter	-	-	-	-	2,650
"Sideral" reflector, with subsidiary pieces	-	-	-	-	500

= \$1,528 12.

8,150

Interest at 5 per cent.	-	-	-	-	407 fr.
Annual expense of the service	-	-	-	-	800

= \$226 31.

1,207

2. *Catadioptric harbor light, (smaller model.)*

Tower and lantern	-	-	-	-	7,650 fr.
Catadioptric apparatus	-	-	-	-	1,531

= \$1,721 43.

9,181

Interest at 5 per cent.	-	-	-	-	459 fr.
Annual expense of the service	-	-	-	-	800
= \$236 06.					<u>1,259</u>

The *useful effect* of the "sideral" (reflector) light having been found equal to 68,400—

Its *economical effect* will be represented here by $\frac{68,400}{1,207} = 57$.

The *useful effect* of the catadioptric light, illuminating three-fourths of the horizon, has been found to be equal to 137,700.

After the same manner, its *economical effect* will be $\frac{137,700}{1,259} = 109$.

The comparison of the *economical effects* of these two will be, then, in the proportion of 57 to 109, or 1 to 1.91.

Then, besides the advantage of a *double lustre* or *brilliancy*, the catadioptric apparatus, in an economical point of view, is nearly twice as advantageous as the catoptric apparatus.

Lights of the third order.

It is difficult to establish a precise comparison between the fixed lights of the third order in the old and in the new system, because we cannot obtain with the ordinary parabolic reflectors a passably equal distribution of light, without multiplying these reflectors to such a number as would require a much greater expenditure of oil than could be allowed for lights of that class.

I will merely observe that I have every reason to believe, from the indications contained in the table of light-houses in the United States, that among all the lights of that country illuminated by reflectors, the diameters of which do not exceed sixteen English inches, there are very few whose *useful effect* is superior, or even equal to that of a catadioptric light of the third order, larger model.

[Revolving lights of the second order.]

1st. Catoptric light.

In the comparative examination of the *useful and economical effects* of the two systems of maritime illumination, I have supposed the revolving catoptric apparatus of the second order, composed of twenty-four parabolic reflectors of fifty centimetres (19.69 inches) of aperture distributed equally upon the six faces of a prismatic frame. I will suppose, also, that the lantern is three metres (9 feet 10.14 inches) in diameter, the same as required for a lenticular apparatus of the second order, but with a little less height. I will admit, moreover, the same perfection in the works; that is to say, that the frame and sashes, constructed of iron, are covered with bronze exteriorly; and that the roof or dome of the lantern is of copper, the glazing of glass of eight to ten milimetres (0.39 to 0.31 of an inch) in thickness, &c.

With regard to the buildings, the only remarkable difference will consist in, that the catoptric light-house will require room to lodge two keepers,

while I will estimate for three in the lenticular light-house. That being stated, the necessary expenses to be incurred in the first system may be approximately estimated as follows:

Light-house tower, &c.	-	-	-	-	50,000 fr.
Octagonal lantern, three metres (9 ft. 10.14 inches) in diameter, dressed in bronze	-	-	-	-	10,500
Illuminating apparatus, consisting of twenty-four reflectors, fifty centimetres (19.69 inches) in diameter, revolving frame, rotary machinery, &c.	-	-	-	-	12,500
Total first cost	-	-	-	-	<u>73,000</u>
= \$13,687 50.					
Interest at five per cent.	-	-	-	-	3,650 fr.
Annual expense of the service, estimating the oil at the highest price	-	-	-	-	5,000
Total annual expense	-	-	-	-	<u>8,650</u>
= \$1,621 87.					

2d. Revolving lenticular apparatus of the second order.

Light-house tower, &c.	-	-	-	-	60,000 fr.
Lantern and subsidiary fixtures	-	-	-	-	12,500
Catadioptric lenticular apparatus and mechanical lamps	-	-	-	-	33,000
Total first cost	-	-	-	-	<u>105,500</u>
= \$19,781 25.					
Interest at five per cent.	-	-	-	-	5,275 fr.
Annual expense of the service	-	-	-	-	5,800
Total annual expense	-	-	-	-	<u>11,075</u>
= \$2,076 56.					

The useful effect of twenty-four parabolic reflectors of fifty centimetres (19.69 inches) diameter will be equal to $24 \times 103,680 = 2,488,320$.

The economical effect will be represented by $\frac{2488320}{8650} = 288$.

The useful effect of a lenticular light of the second order, with twelve revolving lenses, has been valued at 5,021,467.

The economical effect will then be represented by $\frac{5021467}{11075} = 453$.

The *economical effects* of these two lights will then be in the proportion of 288 to 453, or of 1 to 1.6. From whence it results definitely, that the lenticular light of the second order will be *more than one and a half times* as advantageous as the catoptric light, which we may without doubt consider as being of the first order, and the *useful effect* of which, nevertheless, could not be equal to but *the half* of the *useful effect* of the first.

Lights of the first order.

I find myself arrested in the attempt to make a comparison of the catoptric and dioptric lights of the first order, for the reason that we could not,

without increasing beyond all proper limits the number of reflectors and the dimensions of the lantern, construct a catoptric apparatus to produce a sufficiently powerful effect to be assimilated to a dioptric apparatus of the first order. I mention this in this place merely that it may not be forgotten.

From the preceding details we may conclude :

1st. That the lights fitted with the dioptric apparatus present a variety in their power and in their effects, and may be made to produce an intensity of lustre which renders them of an interest in a nautical point of view, incontestably superior to those fitted with the catoptric apparatus.

2d. That if we take into account the first cost of construction, and the expense of their maintainance, we will find, in respect to the effect produced, the new system, (dioptric) is still from *once and a half to twice as advantageous as the old.*

FACILITY AND SECURITY OF THE SERVICE OF THE LIGHT-HOUSES OF THE OLD AND NEW SYSTEMS.

After having balanced the advantages relative to the two systems of lights in view of their *useful and economical effects*, I ought to consider them with reference to their *security* and the *facility* with which they are served.

I will reproduce, upon this subject, the observations inserted in a memoir of the 20th of April, 1830, in which I replied to the questions which were addressed to me by the government of Sweden and Norway, in relation to the necessary measures to be taken to improve the lighting of its maritime coast.

“The service of lenticular lights is, in the aggregate, less laborious than that of the reflector lights. The first, demand at all times during the night the unremitted attention of the keeper. If, for example, the central lamp should become extinct during the absence of the keeper from the lantern, or while he is asleep, the horizon of the light would remain some hours plunged in total darkness, and the greatest objection which has been urged against our new system of illumination is the fear of such accidents. Happily, an experience of *seven years* has dissipated that fear, and the lenticular lights have been distinguished up to this time by the regularity of their service. However, every precaution has, besides, been taken to replace promptly the lamp or its burner in case of extinction. The extreme simplicity of the day duty compensates the keepers for that to which they are subjected during the night. To snuff and replace the wicks, renew the oil, sweep the chambers of the lantern and the stairs of the tower, dust the apparatus, and sometimes wash with a little spirits of wine the tarnished spots upon it, and, lastly, to wipe dry the glass of the lantern—such is the principal daily duty which is divided between the keepers of the new lights, and which rarely occupies them more than two hours.”

Opinions thus expressed *fifteen years since*, based upon an experience of seven years, have been greatly strengthened up to the present time, embracing a period of *twenty-two years* since the establishment of the Cordouan light, and sustained by the results daily offered of more than *one hundred* lenticular lights of the three first orders, established along the coasts as well of France as of different foreign powers,

In this important point of view, then, the question seems to be irrevocably settled, and I will only add a few considerations relative to the application, more or less extended, which may be made of the new system of illumination, to the vast maritime coasts of the United States.

1st. It has been objected that it would require too great sacrifices to be made to procure in that country keepers possessing the amount of intelligence requisite for the superintendence of lenticular lights.

2d. That from distant points or stations the necessary repairing and renewing of the mechanical lamps would be attended with great difficulty.

I will reply, with regard to the *keepers*, that the difficulty of obtaining proper persons to fill these subaltern stations appears to be most singularly exaggerated. In France they belong almost always to the class of *ordinary mechanics*, or laborers, who make from 1.50 francs to 2.50 francs (27 to 46 cents) per day.

Eight or ten days will suffice, ordinarily, to instruct a light-keeper in the most essential parts of his duty, receiving lessons from an instructor conversant with all the details of the service; and two instructing officers will be sufficient to prepare keepers for all the lenticular lights which could be successively established upon the coasts of North America. The information thus imparted, would never be lost; and these officers might, besides, be aided by foremen or assistants, who could supply the place in case of necessity. In defence of this assertion, I will cite the example of the administration of Norway and Sweden, which, after having obtained the assistance of a French agent to put up the apparatus of the two first lenticular lights, which were sent from Paris in 1832 and 1836, has provided since, without any foreign assistance, for the placing, as well as the organization of the service, of all the lights of the new system which it has successively established.

With reference to the eventual repairs of the mechanical lamps, it is to be considered—

1st. That, in consequence of the great strength of the pieces of which the new model of mechanical lamps are composed, they will perform well for a number of years without requiring anything more than a proper attention to their cleanliness.

2d. That the ordinary assortment of a dioptric light-house comprises three of these lamps, which afford a sufficient guarantee against the chances of accident; and besides, we may, by increasing a little the mean expense, increase the number to *four* under some circumstances, as an exception to the general rule.

3d. That the repairs of the implements under discussion may be easily made by all the clock or watchmakers, or other mechanics, to whom we have recourse for repairing the revolving machinery of light-houses.

I conclude with the remark, that if it be determined to multiply the application of the new system of maritime illumination in the United States, it seems to me that it will be expedient to *engage one of the foremen employed in the manufactory of our mechanical lamps to go to, and remain in the country for several years*. By that measure, which would be attended with very little expense, all the difficulties which might present themselves at first in establishing lenticular lights would be removed, and the perfect regularity of the service of these new establishments would be insured.

LEONOR FRESNEL.

PARIS, December 31, 1845.

Brilliancy, range, first cost, and expenses of illumina-

INDICATIONS.	FIRST ORDER, ILLUMINATING THE WHOLE OF THE HORIZON.							
	Catadioptric accessory part.				Catoptric accessory parts.			
	Fixed.	Varied by flashes.	Revolving, with 8 lenses.	Revolving, with 16 lenses.	Fixed.	Varied by flashes.	Revolving, with 8 lenses.	Revolving, with 16 lenses.
Brilliancy in burners of Carcel—								
Maximum	560	2,000	4,400	1,800	480	1,920	4,320	1,720
Minimum	560	200	200	200	480	120	120	120
Ordinary range in nautical miles, 60 to a degree—		?				?		
Maximum lustre	20	27	33	27	20	27	33	27
Minimum lustre	20	18	18	18	20	17	17	17
Prices of the apparatus, with extra pieces and accessory supplies—	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>
Optical parts { Principal	11,200	14,950	11,600	11,200	11,200	14,950	11,600	11,200
{ Accessory	21,000	21,000	21,000	21,000	6,265	6,265	6,265	6,265
		?	?	?				
Frames and accessory pieces	4,000	6,200	6,200	6,200	4,500	6,800	6,800	6,800
3 lamps (2 of which for changing)	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Revolving machinery		3,300	3,300	3,300		3,300	3,300	3,300
Implements, wicks, chimneys, &c.	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Packing and extra expenses	600	750	750	750	600	750	750	750
Total expense	40,000	49,400	46,050	45,650	25,765	35,265	31,915	31,515
Price of the lanterns in iron and bronze, with plate glass, glazing, &c.	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Number of grammes of oil consumed per hour.	750	750	750	750	750	750	750	750
Number of keepers necessary ...	3	3	3	3	3	3	3	3
Annual expense (in France) for illuminating the light-houses on the continent.	7,700	7,900	7,900	7,900	7,700	7,900	7,900	7,900

nating the different orders of lenticular apparatus.

SECOND ORDER CATADIOP- TRIC, ILLUMINATING THE WHOLE OF THE HORIZON.				REMARKS.
Fixed.	Varied by flashes.	Revolving, with 8 lenses.	Revolving, with 12 lenses.	
260 260	1,200 100	1,600 100	1,180 100	Many of the annexed figures would be modified by new experiments. However, these approximate results suffice to establish opinions as to the effect of the different orders of illuminating apparatus.
18 18	22? 16	24 16	22 16	These numbers do not give the <i>absolute range</i> of the lights, but the indications for the navigators, saving the results arising from the greater or lesser elevation of the light-houses. For the lights varied by flashes, we give the ordinary range of fixed lights.
<i>Francs</i> 7,200 12,265 ? 3,300 1,790 900 400	<i>Francs</i> 10,200 12,265 ? 4,260 1,790 3,100 900 500	<i>Francs</i> 7,200 12,265 ? 4,260 1,790 3,100 900 500	<i>Francs</i> 7,200 12,265 ? 4,260 1,790 3,100 900 500	These estimates allow a great many changes, according to the extent of the angular space to be illuminated and the quantity of extra pieces, utensils, and different supplies. The supply of wicks and chimneys is estimated for three to four years.
25,855	33,015	30,015	30,015	
12,500	12,500	12,500	12,500	For the lights of the first three orders I have included the price of the lightning-rod, the gallery and ladder leading to it, (of cast iron,) in estimating the cost of the lanterns.
500	500	500	500	The effective consumption of oil for the first order rarely exceeds 700 grammes per hour.
2	3	3	3	
5,200	5,800	5,800	5,800	For more ample details, consult the "Detail Estimatif," for the illumination of the coasts of France, published in 1839.

STATEMENT

INDICATIONS.	THIRD ORDER CATADIOPTIC, ILLUMINATING THE WHOLE OF THE HORIZON.			
	Larger model.		Smal'r model.	
	Fixed.	Varied by flashes.	Fixed.	Varied by flashes.
Brilliancy in burners of Carcel—				
Maximum	70	400	30	180
Minimum	70	18	30	10
Ordinary range in nautical miles, 60 to a degree—				
Maximum lustre	15	20	13	?
Minimum lustre	15	10	13	9
Prices of the apparatus, with extra pieces and accessory supplies—	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>
Optical parts { Principal	4,050	6,000	3,200	4,000
{ Accessory	4,300	4,300	?	?
Frames and accessory pieces	1,320	2,800	400	1,200
Three lamps (two of which for changing)	1,250	1,250	500	500
Revolving machinery .....	.....	2,200	.....	1,600
Implements, wicks, chimneys, &c.	600	600	400	400
Packing and extra expenses	270	300	150	200
Total expense	11,790	17,450	4,650	7,900
Price of the lanterns in iron and bronze, with plate glass, glazing, gallery, &c.	7,500	7,500	4,500	4,500
Number of grammes of oil consumed per hour	190	190	120	120
Number of keepers necessary	2	2	1	2
Annual expense (in France) for illuminating the light-houses on the continent.	3,500	3,600	2,000	2,400

—Continued.

FOURTH ORDER CATADIOP- TRIC, ILLUMINATING THE WHOLE OF THE HORIZON.				REMARKS.
Larger model.		Smal'r model.		
Fixed.	Varied by flashes.	Fixed.	Varied by flashes.	
15	120	9	90	Many of the annexed figures would be modified by new experiments. However, these approximate results suffice to establish opinions as to the effect of the different orders of illuminating apparatus.
15	?	9	?	
	6			
10	??	9	?	These numbers do not give the <i>absolute range</i> of the lights, but the indications for the navigators, saving the results arising from the greater or lesser elevation of the light-houses. For the lights varied by flashes, we give the ordinary range of fixed lights.
10	17	9	15	
	?		?	
<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	<i>Francs</i>	These estimates allow a great many changes, according to the extent of the angular space to be illuminated and the quantity of extra pieces, utensils, and different supplies. The supply of wicks and chimneys is estimated for three or four years.
1,700	2,200	1,000	1,360	
200	1,000	180	680	
102	102	81	81	
.....	920	.....	800	
250	250	220	220	
60	130	50	90	
2,312	4,602	1,531	3,231	
3,000	3,000	2,650	2,650	For the lights of the first three orders I have included the price of the lightning-rod, the gallery and ladder leading to it, of cast iron, in estimating the cost of the lanterns.
60	60	45	45	The effective consumption of oil for the first order rarely exceeds 700 grammes per hour.
1	1	1	1	
1,000	1,100	800	900	For more ample details, consult the "Detail Estimatif" for the illumination of the coasts of France, published in 1839.

PARIS, January 11, 1846.

LEONOR FRESNEL.

DEPARTMENT OF
LIGHT-HOUSE OF

LIGHT-HOUSES AND BEACONS.

CONTRACT FOR
LIGHTING.
A¹

Report of the oil consumed for the illumination of the light-house, in the month of 184 .

Days of the month.	Hours of lighting.		Hours of extinguishing.		Duration of illumination.		Weight of oil consumed.		Remarks.
	Hours.	Minutes.	Hours.	Minutes.	Hours.	Minutes.	Kilogrammes.	Grammes.	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
Total..									

Certified by the principal keeper

Approved by the undersigned engineer

Approved by the deputy of the lighting contractor, the — day of —, 184 .

LIGHT-HOUSE OF {

LIGHT-HOUSES AND BEACONS.

{ ILLUMINATED BY
ADMINISTRATION.

A2

Report of the oil consumed for the illumination of the light-house of
month of 184 .

for the

Day of the month.	Hours of illuminating.		Hours of extinguishing.		Duration of illumination.		Weights of oil consumed.		Remarks.
	Hours.	Minutes.	Hours.	Minutes.	Hours.	Minutes.	Kilogrammes.	Grammes.	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
Total									

Certified by the principal keeper.

Approved by the undersigned conductor, the

184 .

Approved by the undersigned engineer.

LIGHT-HOUSE OF

LIGHT-HOUSES AND BEACONS.

CONTRACT FOR
LIGHTING.
B1

[28]

Report of the supplies the most essential to the service in store on the

184 .

of

610

Dates.	Weight of oil.		Length of wicks.				Linen.		Chamois skin.	Weight of polishing rouge.	Litres of spirits of wine.	Vials of clock oil, or neatfoot oil.	Plate glass for glazing the lantern.	Remarks.
	Proper to burn.	Unfit for use.	No. 1.	No. 2.	No. 3.	No. 4.	Towels.	Cleaning rags.						
There was in store on the 1st														
Received in that month														
Total														
Deduct consumption during the month														
Remaining in store on the 1st														

Verified by the deputy of the contractor for light-
ing, the 184 . of

Certified by the principal keeper, the 184 .

Approved by the undersigned engineer.

LIGHT-HOUSE OF

LIGHT-HOUSES AND BEACONS.

ILLUMINATION BY
ADMINISTRATION.

B².

Report of the supplies the most essential to the service, in store on the of 184 .

Dates.	Weight of oil.		Length of wicks.				Linen.		Sheepskin for mechanical lamps.	Chamois leather.	Weight of polishing rouge.	Litres of spirits of wine.	Vials of clock oil, or neat's foot oil.	Plate glass for glazing lantern.	Remarks.
	Proper to burn.	Unfit for use.	No. 1.	No. 2.	No. 3.	No. 4.	Towels.	Cleaning rags.							
There was in store on the first of.....															
Received during the month..															
Total received.															
Deduct consumption of the month															
Remaining in hand on the 1st of.....															

Verified by the conductor of the arrondissement, the Certified by the undersigned, principal keeper, the Approved by the undersigned engineer.

of 184 . of 184 .

LIGHT-HOUSES AND BEACONS.—No. 1.

Illumination of the channel.—Department of Calvados.—Supplies of oil.—Duty of 1839, 3d quarter.—[To pay 738f. 69c.]
Statement of the sums due to the Messrs. Desforges & Bréard, for the supply of oil of colza, and for divers expenses incurred for the illuminating of the light-houses and beacons in the department of Calvados, during the 3d quarter of 1839.
 Mean of prices, at the market of Lille, of the hectolitre of the oil of colza unpurified, 75f. Price of the hectolitre delivered at Dunkerque, (under the detail No. 2,) 85f. 40c.

Designation of the lights.	Description and number of lights.	Annual consumption of oil.	Price of purified oil under detail No. 3.		Weight of oil delivered in 3d quarter.	Amounts.	Remarks.
			Hectolitre.	Kilo-gramme.			
Honfluer.....	{ Hospital Jettee.....	Kilogs. { 265	Fr. cen. { 94 31	Fr. cen. { 1 04	Kilogs. { 132.50	Fr. cen. { 137 80	
	{ North Quay.....						
Mouth of la Tonques	{ Fanal d'Aval.....	60					
	{ Fanal d'Amont.....	212	94 31	1 04	90.50	94 12	
Mouth of the Orne..	{ Dunse.....	145					
	{ Church of Oystreham..	220	96 75	1 06	92.20	97 73	
Port of Courseulles.....	{ "Sideral" reflector.....	180	96 75	1 06	65.00	68 90	
Pt. de Ver.....	{ "Sideral" reflector.....						
	{ Lenticular light, 3d order eclipse.....	845	96 75	1 06	227.30	240 94	
One-tenth profit, and for extra expenses.....							639 49
To which must be added the increased expenses of different kinds annexed hereto.....							63 95
Total amount due.....							703 44
							35 25
							738 69

Certified by the undersigned, engineer-in-chief at Caen, the of October, 1839.
 Examined and approved, by the prefect of Calvados, at Caen, October, 1839.

Statement of the supplies of the oil of colza, wicks, glass chimneys, and other objects of consumption, the most essential for the service of the Barfleur light-house, to the 1st September, 1839.

Barfleur light-house. Service of 1839.

Dates.	Weights of the oil of colza.	Length or No. of wicks for mechanical lamps.				Length or No. of wicks for lamps with double current of air.	Glass chimneys.	Linen.		Sheepskins for the mechanical lamps.	Chamois skins.	Weight of polishing rouge.	Litres of spirits of wine.	Vials of oil for clock work.	Plate glass for glazing lantern.	Remarks.
		No. 1.	No. 2.	No. 3.	No. 4.			Towels.	Cleaning rags.							
On the 31st October, 1839, there were in the store..... Received in the month of November.....	Kilo's.	Metres	Metres	Metres	Metres	Metres						Kilo's.				There are, besides, in store, 1 cord extra for the machinery; 2 cords extra for the lamps; 1 litre of linseed oil; $\frac{1}{2}$ kilogramme of white lead; 1 kilogramme of Spanish whiting; 1 litre spirits of turpentine. A central pane of glass has been broken during the gale of 12th Nov. It was replaced the same day, at 4 o'clock p. m.
	645	4.20	3.25	5.30	5.20	.....	45	6	12	1	2	$\frac{3}{4}$	2 $\frac{1}{2}$	1 $\frac{1}{4}$	5	
Consumed in November.....	505	5.00	5.00	5.00	5.00	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	There are, besides, in store, 1 cord extra for the machinery; 2 cords extra for the lamps; 1 litre of linseed oil; $\frac{1}{2}$ kilogramme of white lead; 1 kilogramme of Spanish whiting; 1 litre spirits of turpentine. A central pane of glass has been broken during the gale of 12th Nov. It was replaced the same day, at 4 o'clock p. m.
	1,500	9.20	8.25	10.30	10.20	.....	45	6	12	1	2	$\frac{3}{4}$	2 $\frac{1}{2}$	3 $\frac{1}{2}$	5	
Remaining in store on the 1st December.....	272	0.80	0.80	0.80	0.90	.....	2	.....	.....	.....	.....	.....	.....	.....	1	There are, besides, in store, 1 cord extra for the machinery; 2 cords extra for the lamps; 1 litre of linseed oil; $\frac{1}{2}$ kilogramme of white lead; 1 kilogramme of Spanish whiting; 1 litre spirits of turpentine. A central pane of glass has been broken during the gale of 12th Nov. It was replaced the same day, at 4 o'clock p. m.
	878	8.40	7.45	9.50	9.30	.....	43	6	12	1	2	$\frac{3}{4}$	2	3 $\frac{1}{4}$	4	

Certified by the principal keeper of the Barfleur light-house, 3d December, 1839.

STATEMENT—Continued.

Designation of the lights.	Description and number of lights.	Value of the oil consumed annually.		Annual expenses, not including expense of oil and salaries of keepers, but including the benefit of 10 pr. cent. upon those salaries.			Salaries and indemnities, not subject to reduction.	Expenses of each light per year.		Expenses of each light per quarter.	Remarks.
		(a) Fr. cen.	(b) Fr. cen.	Amounts in detail. Fr. cen.	Reduction of 23 per cent. Fr. cen.	Reduced expenses. Fr. cen.		(c) Fr. cen.	(a+b+c) Fr. cen.		
Isle of Porquerolles.	Lenticular light of 1st order, with short eclipses.	3,766 35	262 11	1,574 41	262 11	2,212 30	1,850 00	6,828 65	1,707 16		Detailed calculation for the Porquerolles light, (1st column.)
Isle du Levant.....	Lenticular light of 3d order, fixed light.....	1,014 00	301 13	1,309 26	301 13	1,008 13	1,250 00	3,272 13	818 02		Price of oil delivered at Dunkerque.....
Cape Camarat.....	Lenticular light of 1st order, eclipse.....	3,798 00	327 61	1,424 41	327 61	1,096 80	2,000 00	6,894 80	1,723 70		Freight to light-house, &c. (S. D. No. 3.....)
La Garoupe.....	Lenticular light of 1st order, fixed light.....	3,766 35	295 07	1,282 91	295 07	987 84	1,850 00	6,604 19	1,651 05		Waste, 4 per cent.....
Mole of Antibes....	Small light of 4th order, with short eclipses.....	304 20	67 22	292 28	67 22	225 06	450 00	979 26	244 82		Commission and extra expense
											Total (equal to No. in 1st col.)
									6,114 76		The detailed estimates allow the annual expense of the Porquerolles light to be....
									75 30		8,089 62
											From which must be deducted:
											value of oil, 4,241f. 10c.; 10 pr. ct. 424f. 11c.; salaries of keepers, 1,850f., making...
											6,515 21
											Remaining
											1,574 41

To that sum must be added, in consideration of the different expenses detailed in the annexed note (A)...

Total.....

From which must be deducted, according to contract

Remainder.....

Certified by the undersigned, engineer-in-chief at Draguignan, the of October, 1839.

Examined and approved by the prefect of the Var, at Draguignan, the of October, 1839.

TRANSLATION.

[Ministry of Public Works—Second bureau—Navigation—Light-houses.]

Control of the consumption of oil, and of the condition of the different supplies.

PARIS, March 17, 1845.

SIR : The great expense incurred by the administration for the purpose of carrying the illumination of our maritime coasts to a degree of perfection which will insure the safety of navigators, will not fulfil perfectly that object if the service is not, on the part of the engineers, an object of their special care and superintendence ; yet, however active they may be, it will be conceded that they may fail very often in the accomplishment of their object. We may, doubtless, by a minute inspection of the apparatus, the implements, and the supplies, judge if the light-keepers have at their command all the elements requisite to an efficient service, and if they are employed with all proper care. We may equally discover, either from observations made at a distance, or unexpected visits, if the perturbations observed in the illumination of the light-houses arise from the negligence of the keepers, or from their want of capacity ; but these means only afford us an idea of the mean state of the illumination, and from which we may accidentally discover some isolated facts ; but that will not suffice for the proper direction of a service of public safety, the normal condition of which should never be permitted to be interrupted.

To obtain a more positive and a more efficient control, without recourse to an unremitted supervision, which would require a large number of special agents, it has appeared to me that the most direct and the surest means was to require the principal light-house keepers to keep a regular account of the oil consumed each night for the illumination of their lights. Doubtless there is reason to fear that these accounts will not always be correct ; but we shall, sooner or later, detect false declarations by the details of the monthly tables, of which we will speak hereafter.

This new plan, already put into practical operation with perfect success in some light-houses, is only applicable to the lenticular apparatus, illuminated by lamps with multiple wicks. These lamps require in their management unremitted attention and care, to insure a proper development of their flames. We have, also, generally to encounter the lazy tendency of the keepers in keeping habitually the flames of the lamps below their normal height.

This is a capital point, and is the hinge on which the whole light-house service turns.

The table to be filled by the principal keepers must be kept in conformity to the accompanying model, (A¹) divided into six columns, which comprise respectively the following indications :

First column, the day of the month.

Second column, the hour of lighting.

Third column, the hour of extinguishing.

Fourth column, the duration of the illumination.

Fifth column, the weight of the oil consumed.

Sixth column, the remarks.

The direct weight of the oil put each day into the reservoir of the lamp, and the residue which is drawn off after extinguishing the light, will present in the service a complication which may be avoided by means of a gauging table.

To construct that table we may proceed as follows: Refill the reservoir of the lamp by pouring one kilogramme of oil at a time into it; note at each time the number in millimetres corresponding to the depth of the liquid, and, in dividing by ten the successive differences, we will determine the numbers answering to the graduated weight of each hectogramme.

If the three or four lamps employed in the light-house have not their reservoirs of exactly the same shape, it will become necessary to construct a special gauging table for each lamp, which must, in that case, be distinctly marked, so that they may not produce mistakes. The reports of the consumption of oil for each month must be signed (at the end of each month) by the principal keepers, who will address them in triplicate to the deputy of the lighting contractor, or to the conductor of the arrondissement, according as the supplies are furnished by contract or the administration. One of the three copies will be retained by the deputy or conductor, and the two others, with the signature of that agent upon them, must be transmitted to the engineer of the arrondissement. Lastly, one of the two last must be sent to the engineer-in-chief, who, after having signed it with or without remarks, addresses it to the secretary to the commission of lights.

Independently of these tables, destined specially to control the nocturnal service of the lighting establishment, it is necessary to continue to require the principal keepers of the lights under the administration, as well as those under the contractors, to furnish monthly statements of the condition of those supplies—the most essential to the illuminating service.

The accompanying model (B²) is used by the administration, and is applicable to the contracts, by substituting the approval of the deputy of the contractor for that of the conductor or agent of the administration. These latter reports must be made out in quadruplicate, disposed of in the same manner that the others were, and forwarded under the same cover.

This second precautionary measure will have the advantage of furnishing a base of verification for the daily consumption of oil, and of apprizing the engineers at the same time, more readily, if the light-houses are supplied at all times with all the objects necessary as well for the service of the illumination as the maintenance of the apparatus confided to the light-keepers.

To prevent these new measures from imposing any expenses upon the contractors not contained in the table of charges, the administration will furnish the lithographed sheets necessary for the keeping of the two different tables; and they will be sent under cover to the engineers or conductors.

I pray you, sir, to have the kindness to communicate this circular to the engineers and conductors charged, under your orders, with the service of the light-houses, and require the strictest execution of all duties embraced in it.

Receive, sir, the assurance of my very distinguished consideration,

UNDER SECRETARY OF STATE FOR THE PUBLIC WORKS.

To Monsieur ———, *Engineer-in-chief at*

[Translated from the French.]

MEMOIR PRESENTED TO THE ACADEMY OF SCIENCES, JANUARY 8, 1844.

[Létourneau & Co., successors of Messrs. Soliel, sr., and François, jr., constructors of dioptric lights upon the system of Mr. A. Fresnel, "Rue des Poissonnières, No. 24, près et hors la barrière Poissonnières à Paris."]

Note upon the catadioptric apparatus constructed by Mr. François, jr., for the Scotch light at Skerryvore.—(Commissaries, M.M. Arago, Mathieu, Babinet.)

The lenticular apparatus imagined by M. Augustin Fresnel comprises, independently of the fixed or movable dioptric drum, an accessory part, destined to collect and direct towards the horizon the luminous rays which, issuing from the focal centre, pass above and below the lenses.

This accessory part has been in most cases formed by a system of fixed concave mirrors, arranged in horizontal zones, both above and below the lenticular drums.

In the two light-houses of *Cordouan* and *Marseilles*, the revolving dioptric drum is surmounted by a system equally movable, composed of eight lenticular panels arranged in the form of a truncated pyramid, and as many plane mirrors to convey towards the horizon the eight luminous beams of light emerging perpendicularly to the faces of the pyramid. A third combination, preferable to the two others in the double aspect of theory and practice, has been applied by the inventor to the small lenticular lights of twenty-five to thirty centimetres of interior diameter. In these apparatus, which, in consequence of their small size, are not adapted to the employment of mirrors, the accessory catoptric system has been replaced by a catadioptric system of rings or zones, in triangular section, producing total reflection.

The first apparatus of this description was constructed a short time before the death of M. Augustin Fresnel, by M. Tabouret, conductor of bridges and roads, attached to the special service of the light-houses.

The application of this system to the apparatus of the largest size ought, at that time, to have appeared almost impossible. Scarcely, in fact, could the shape of the dioptric rings of seventy-five to eighty centimetres in diameter for the large plano-convex lenses be obtained. As to the fixed dioptric drums, of diameters exceeding thirty centimetres, they were composed of cylindrical elements, the assemblage of which presented, in place of an annular, a polygonal system of sixteen sides for the apparatus of fifty centimetres diameter, (third order smaller model;) twenty sides for the apparatus of one metre in diameter, (third order larger model;) twenty-four sides for the apparatus of one metre forty centimetres in diameter, (second order;) and thirty-two sides for the apparatus of one metre eighty-four centimetres in diameter, (first order.)

A catadioptric polygonal system could, without doubt, be executed by the means employed for the polygonal dioptric system; but the adjustment of such a multitude of prisms of reflection, the positions of which could not be exactly regulated except when put up, presented an inadmissible complication.

It was necessary, for the practical solution of the problem, that the moulding and cutting of the large pieces of glass should be performed by an

improved method. A manufacturer of mirrors at Newcastle-upon-Tyne, England, (Mr. Cookson,) placed, with regard to the making experiments upon the subject, in a singularly favorable position, because of the facilities of every description which his vast establishment afforded him, made the first attempt, in 1836, to construct the dioptric drums of the first order entire, which up to that time had been formed in prisms of thirty-two panels. The results of these first essays, without being fully satisfactory, stimulated the zeal of the French artists, who were devoting themselves to the fabrication of the lenticular apparatus; and very soon after, we obtained dioptric drums of nearly two metres in diameter, executed entire, with a precision which increased the useful effect of that principal part of the apparatus about one-fourth.

From that time the project of constructing upon a large scale the catadioptric apparatus was permitted to recommence, with some chances of success. However, the considerations of expense and little prospect of profits, &c., were very discouraging.

Nevertheless, the able Scotch engineer charged with the construction of the Skerryvore light-house (Mr. Alan Stevenson) devoted himself with zeal and assiduity to the idea of crowning that monument (which cost about two millions of francs) with the most perfect illuminating apparatus which it was possible to construct, in the present state of the arts and sciences.

The programme was adopted by the commission of Scotch light-houses, and it was determined that the Skerryvore rock should be marked by a catadioptric apparatus of the first order, the optical parts of which should be constructed at Paris.

A correspondence followed upon the subject between Mr. Alan Stevenson and Mr. Leonor Fresnel, the engineer-secretary of the commission of French lights. The latter first calculated the elements of, and caused to be constructed, as a first attempt, two catadioptric apparatus of one metre diameter, (third order,) one of which, constructed at the establishment of Mr. Henry Lepaute, has illuminated for some months past the entrance to the port of Gravelines; and the other, constructed by M. François, jr., is destined for the light-house which is being erected at the mouth of the Abervrach, upon the northwest coast of Finisterre.

In spite of the complete success of the first experiment, the fabrication of the reflecting rings of the first order always presented itself as a grave and perilous enterprise.

Even the secretary to the commission of French lights, in remitting to M. François, jr., the table of the centres and radii of curvature of the nineteen glass rings or zones which were required to form the catadioptric part of a first order light, deemed it his duty to insist that that artist should weigh well the engagement which he was about entering into with the administration of the Scotch lights. M. François, jr., did not hesitate a moment. He undertook resolutely a work of great public utility, which required in its accomplishment the overcoming of grave difficulties.

One may form some idea of these difficulties by a simple inspection of the table of radii of curvatures of the reflecting surfaces of the catadioptric rings, which vary from 6,816 metres to 8,749 metres.

The ring No. 1, which answers to the maximum radius, has two metres of exterior diameter. The two adjacent sides of the obtuse angle (of $117^{\circ} 26' 42''$) have respectively 92.380 millimetres and 95.209 millimetres of length. The two refracting faces have been supposed rectilinear in the

calculation ; but in consequence of the difficulty of executing with precision conic surfaces, we have (following the ingenious idea of the inventor) substituted for the two generating right lines two arcs of a circle of equal radius, (four metres,) taking care to turn them in an inverse sense, so that the convergence resulting from the convexity of one face was compensated by the divergence resulting from the concavity of the other face.

Each ring has been composed of four equal arcs.

These pieces were first run into a rough shape at the manufacture of Saint Gobain, in the moulds furnished by M. François, jr.

The first operation presented difficulties which would have discouraged one less determined, and one possessing a mind less fertile in resources.

Each rough ring was afterwards rubbed with grit or freestone, smoothed with emery, and polished with English red, upon a circle moved by steam machinery.

It may be conceived now many precautions are required in the perfect execution of an annular reflecting surface, which is cut or shaped by means of a rubber, grinding it with an oscillating arm or lever of eight metres seventy-five centimetres in length, and how much more care ought to be taken to study the means by which to insure the rigidity of this arm or lever, as well as the exactitude of the position and the fixedness of the centre of rotation.

Not only has this difficult problem been solved with perfect success, but it has been done without groping or wavering, without false movements, and without having to regret the loss of one ring broken upon the grinding circular frame.

After having been verified by the reflection of a red ball placed in their focus, the rings or zones were put together in panels.

To fulfil the requirements of Mr. Alan Stevenson, M. François, jr., divided his catadioptric dome or cupola into eight spindles, embracing, each forty-five degrees. One of these spindles has been put under experiment twice at the observatory. Illuminated by a lamp of the first order, with four concentric wicks, burning from 670 to 700 grammes of oil per hour, this catadioptric panel presented a brilliant bar of light, which, after the mean of six observations of equal shadows, was equivalent to one hundred and forty burners of the Carcel lamp, burning forty-two grammes of oil per hour.

The catoptric cupola, which the new system replaces, is composed ordinarily of seven horizontal zones, containing each thirty-two concave mirrors. Its brilliancy appeared greater or lesser according as it was placed in the direction of the axis, or of the intervals of the mirrors, but the mean lustre corresponding to the useful effect has been found to be eighty-seven burners of Carcel.

Thus, then, the useful effect of the new crown is to that of the old one as 1.61 to 1.

It is to be presumed that the same results would be found to exist, or pretty nearly the same, for the part below the lenticular drum ; and as we have found forty-six burners for the mean brilliancy of the four lower zones of mirrors, we may count upon seventy-four burners for the brilliancy of the six corresponding catadioptric rings. The value of a fixed lenticular drum of the first order, with annular elements, being, besides, equal to 360 burners, we may recapitulate by the following little table, the approximation to which it refers :

Lustres or brilliancy, measured in burners of Carcel.

			First system.	Second system.
1. Fixed dioptric drum	-	-	360 burners.	360 burners.
2. Accessory parts	{	Cupola	87	140
		Lower zones	46	74
Total	-	-	493	574

Finally, the substitution of the prismatic rings in place of the mirrors of a first order fixed light, will augment the mean brilliancy eighty-one burners; that is to say, more than equal to the value of a light of the third class.

To that increase of the effect of sixteen and a half per cent. upon the total brilliancy, two capital advantages are joined: one, the equal distribution of light, and the other the stability of the reflecting power of the catadioptric rings.

Although the fiscal question is only one of a secondary consideration here, yet perhaps it may not be superfluous to say a word upon it in concluding.

The system of eleven zones of curved mirrors of a light of the first order costs, including the subsidiary pieces	-	6,000 francs.
The corresponding catadioptric system has been tendered for the price of	-	20,000
Augmentation	-	14,000

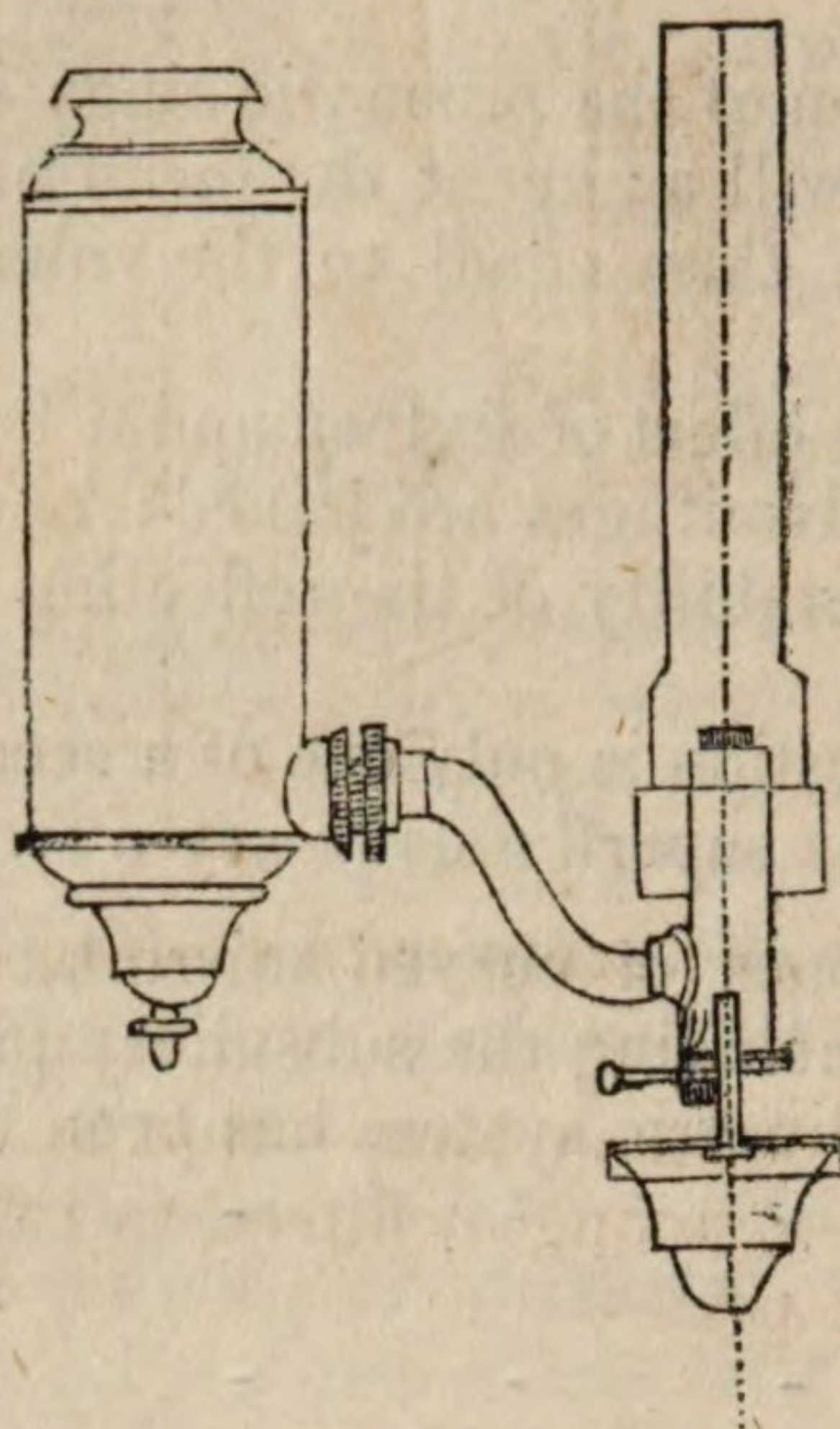
If, then, we take for example a light of the first order, costing annually for illuminating, and the ordinary service	-	7,500
Add the interest on first cost of illuminating apparatus	-	1,500
		9,000

we will find that the above calculated advantage of sixteen and a half per cent. would be equal to 1,485 francs, a larger sum than the interest upon the 14,000 francs, the excess of the price of acquisition.

Thus, then, considering the new system in a fiscal point of view only, we perceive that the augmentation of useful effect which it will produce will not be acquired at too high a price.

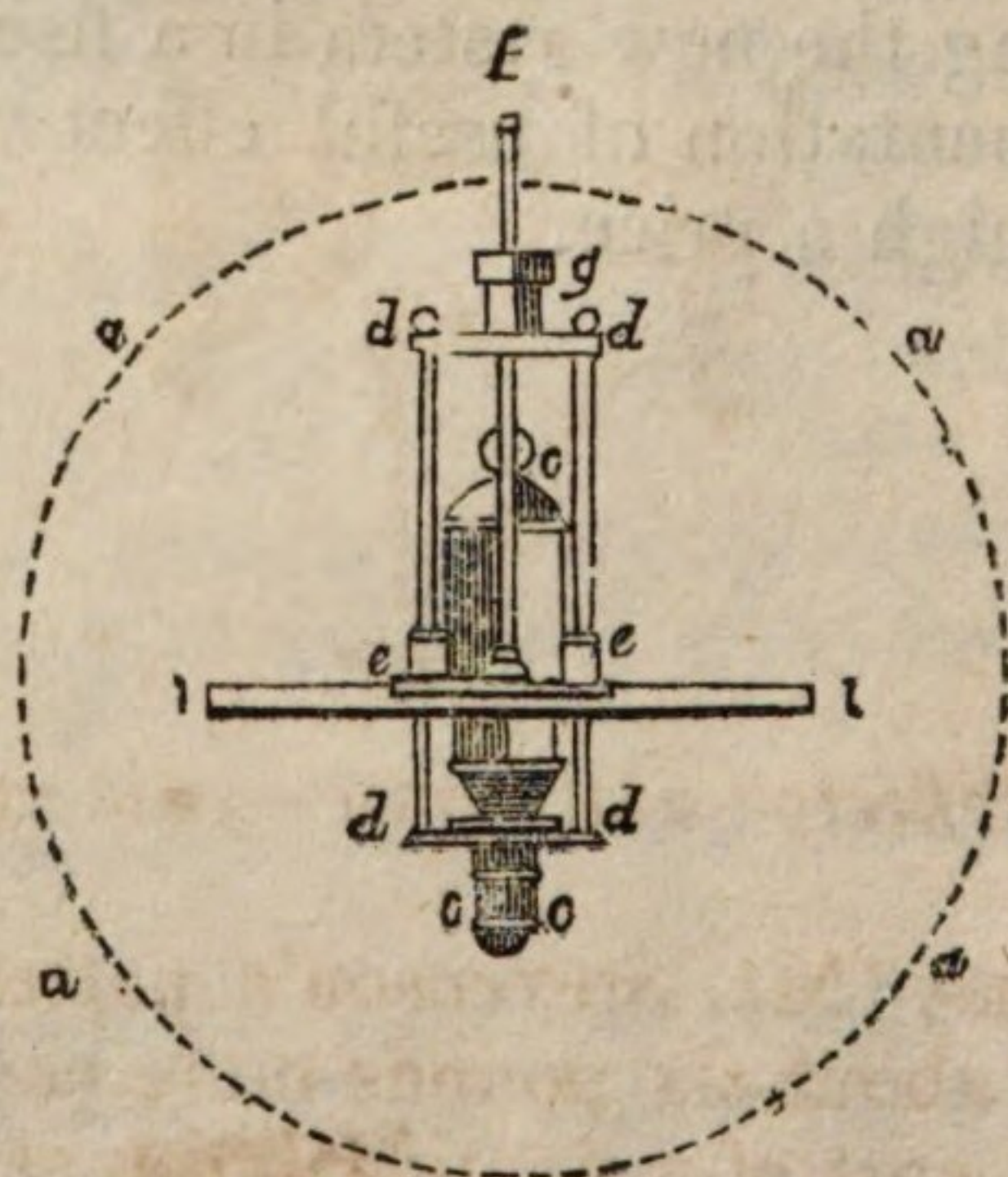
SOHO, NEAR BIRMINGHAM, November 19, 1845.

In conformity with your request, we now transmit for your information our charges for parabolic reflectors and lamps complete, both for light-house and for floating-light uses, with the general sizes and qualities of metal for the same.



Argand lamp and burner.

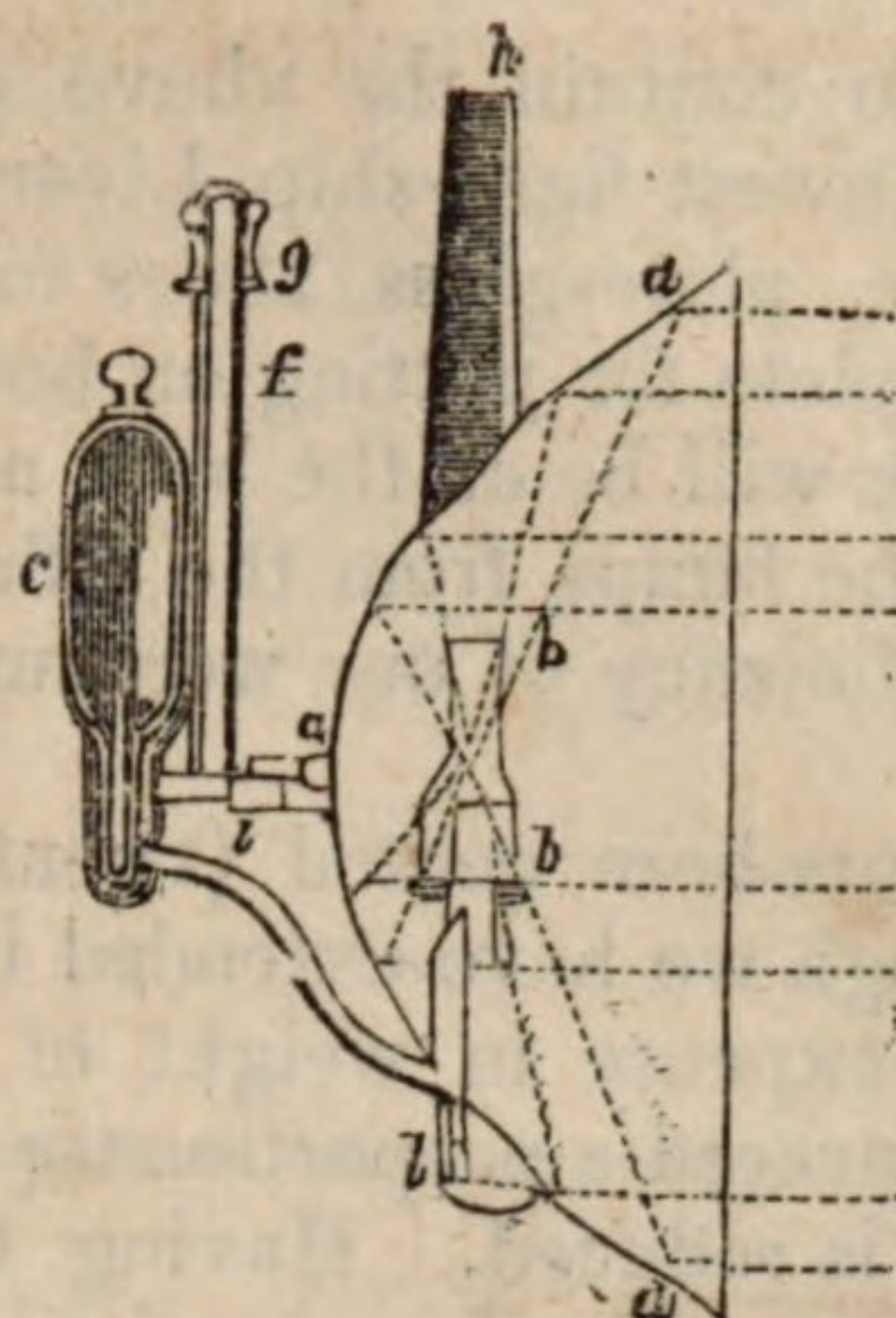
Reflectors, twenty-one and a half inches in diameter, of the quality of two and a half ounces of silver to the pound avoirdupois of copper, (the quality we make for Mr. Halpin, of the Irish light-house board in Dublin,) fitted with brass bands, rings, hooks, &c., together with a brass vase lamp, the burner and parts exposed to heat edged with silver, the whole fitted complete for the frame, £21 each, net.



Reflector and lamp with sliding apparatus -back view.

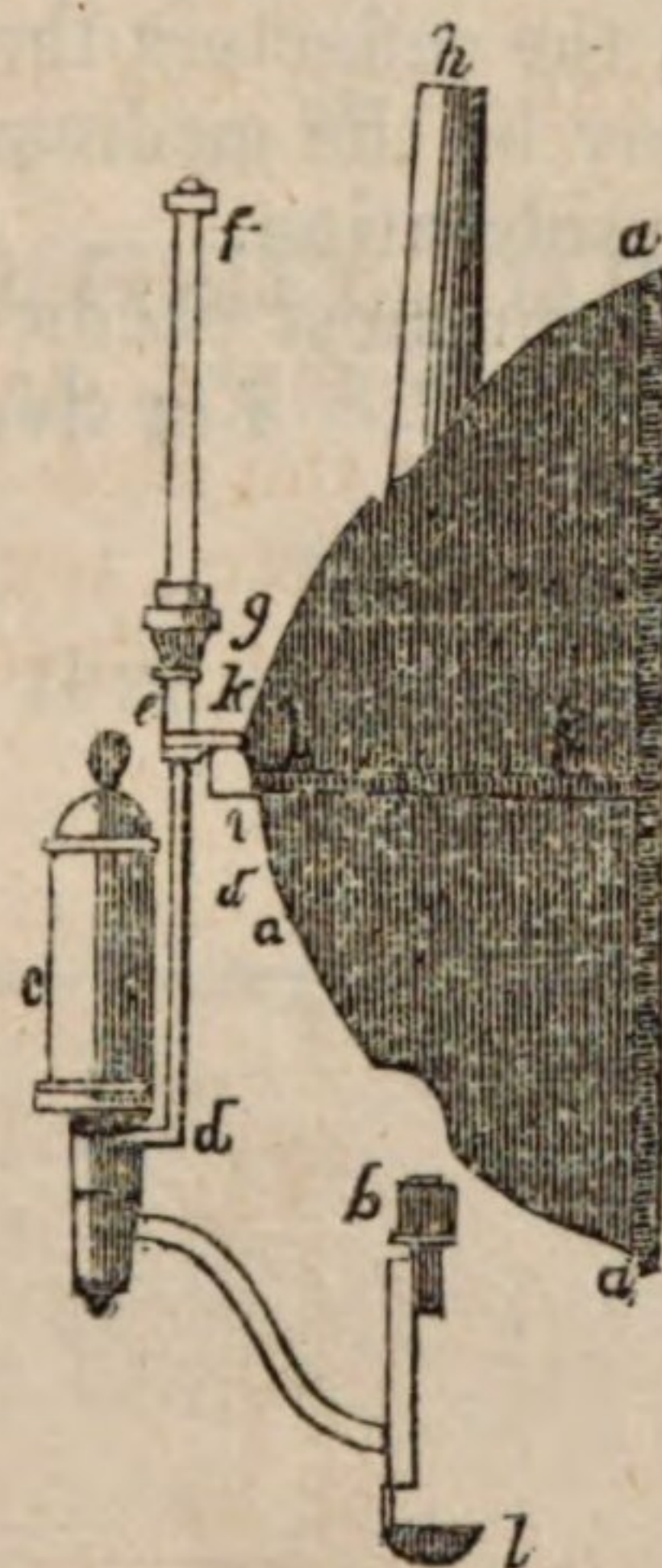
The same, but with four ounces of silver to the pound of copper, £25 10s. net.

The same, but with six ounces of silver to the pound of copper, (the quality manufactured for Mr. Stevenson, of the Northern light-houses,) £32 net.



Parabolic reflector and lamp with sliding apparatus—section.

Should you prefer the ordinary lamp—that is, without the precautionary addition of silver edges—a saving of fifteen to twenty shillings each may be deducted from the above prices.



Reflector and lamp—side view.

The sliding lamp (say Mr. Stevenson's pattern) is a more expensive article, and would cost about six pounds more each, in addition to the preceding estimates. The cost of a floating light, same in all respects as each of those on the northwest light-ship Liverpool, consisting of eight parabolic reflectors, twenty-one and a half inches diameter, four ounces of silver to the pound avoirdupois of copper, fitted with brass lamps and stands to support both reflectors and lamps on an independent platform, the reflectors

fitted on an octangular shape to embrace the mast, and all keyed together, will be £216.

The same in all respects, but with two and a half ounces of silver to the pound of copper, £180.

The cost of a lantern to contain the above eight reflectors and stands, same as those on the northwest light-ship Liverpool, with copper roof and bottom, iron-work frames, plate-glass, slides for taking out reflectors, and all necessary fittings complete for putting on board, £250.

The whole of the above will be of the best materials and workmanship. We have not separated the lamps from the reflectors, considering that we could not guaranty the efficiency of our work unless all were completed by our own people.

The diameter of reflectors here quoted (twenty-one and a half inches) is a general one; and although we have extended it a few inches in some cases without much increased expense in weight of metal or workmanship, in practice we have not discovered a proportionate increase of light, while the strength of the reflector is reduced. Having been employed for a great number of years by the honorable the commissioners of Northern as well as the Irish light-houses, by the Trinity House, the trustees of the Liverpool docks, and other public companies, we have reason to suppose satisfaction has been given in the completion of the orders with which we have for so long a time been honored.

We take this occasion to enclose a letter from Mr. Stevenson to Mr. Pleasonton, of the United States Treasury, which was given to our partner (Mr. Aston) some time ago; the reflectors there referred to were soon after disposed of, but the letter may be the medium of introducing our establishment to that gentleman's consideration.

We remain, respectfully, your most obedient servant,

For SOHO PLATE CO. & SELF.

J. ROBINSON.

Lieuts. JENKINS & BACHE,
U. S. Navy,
London,

FORMS
FOR
LIGHTKEEPERS' RETURNS
OF
RECEIPTS AND EXPENDITURES—DAILY JOURNAL—METEOR-
OLOGICAL JOURNALS, &c., &c.,
IN
ENGLAND, IRELAND, AND SCOTLAND.

Account of oil expended at the

Days of the month.	Expenditure of oil.					Dozen of wicks.	Number of glasses.	Wind.		Weather.		Time of lighting.		Keeper on watch.
	Gallons.	Quarts.	Pints.	Half pints.	Naggins.			A. M.	P. M.	A. M.	P. M.	H.	M.	
1														
2														
3														
4														
5														
6														
7														
8														
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10														
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21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
Total														

NOTE.—This return is made by the keepers,

light-house, in the month of

at the end of every month, to the inspector.

Keeper.

Lightkeeper's account of receipt and expenditures of oil.

	Gallons.	Quarts.	Pints.	Half pints.	Naggins.		Gallons.	Quarts.	Pints.	Half pints.	Naggins.
Oil in store the 1st of this month....						Oil consumed this month, as per light- keeper's account..					
Oil received the ——— of this month						Thick sperm re- turned this month.					
						Oil in store the last day of this month..					
Gallons.											

List of stores wanted.

No. 6.—IRISH LIGHT-HOUSES.

The corporation for preserving and improving the port of Dublin,

To

Dr.

Residence,

[illegible]

Return from
light-house for the month of
18 .

Return from
light-house for the month of
18 .

Principal Lightkeeper.
Assistant Lightkeeper.

Number of reflector burners,
Number of refractor burners,

Written by me.

*Abstract of oil at**light-house, 18 .*

Month.	Day.		Gallons.	Quarts.
		Stock brought from last return		
		Stock received		
		Total		
		Oil expended this month		
		Stock carried to next return		

Principal Lightkeeper.

Monthly letter, containing remarks by the principal lightkeeper; independently of which, he is directed to write to the engineer as often as the circumstances of the service require.

LIGHT-HOUSE,

18 .

SIR :

ALAN STEVENSON,

Engineer for the Northern light-house Commissioners, Edinburgh.

No. 13—SCOTCH LIGHT-HOUSES.

Account of oil consumed at the light in the month of 184 ; also the time (in hours and minutes) of lighting, extinguishing, and exhibiting the light ; with the number of cylinders broken, and cotton wicks consumed each night ; the state of the weather, &c. An account of all which is directed to be accurately kept, and carefully inserted.

Days of the month.	Time of lighting.		Time of extinguishing the light.		How long exhibited.		Oil consumed.					Cylinders broken.	Cotton wicks consum'd.	State of the weather and other observations.
	Hours.	Minutes.	Hours.	Minutes.	Hours.	Minutes.	Gallons.	Quarts.	Pints.	Half pints.	Gills.			
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
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21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
Total quantity consumed in the lantern of the light-house.....														
*Total quantity consumed this month for use in the dwelling-house.....														
Total in this month.....														

Lightkeeper.

* The account of the quantity of oil consumed in the dwelling-house must be kept wholly distinct in future, and cannot be allowed in any way to interfere with the statement of the quantity consumed in the exhibition of the light.

Lightkeeper's account of receipts and expenditure of oil.

	Gallons.	Quarts.	Pints.	$\frac{1}{2}$ pints.	Gills.	Gallons.	Quarts.	Pints.	$\frac{1}{2}$ pints.	Gills.
To oil remaining at the light-house the first of this month.										
To oil received at the light-house this month.....										
Total.....										
By oil consumed this month..										
By sperm returned.....										
By oil remaining at light house.....										
Total.....										

Agent's account of receipts, &c.

	Gallons.	Quarts.	Pints.	$\frac{1}{2}$ pints.	Gills.	Gallons.	Quarts.	Pints.	$\frac{1}{2}$ pints.	Gills.
To oil in store in the warehouse first of this month.....										
To oil received.....										
Total.....										
By oil sent to the light-house..										
By thick sperm returned.....										
By oil remaining in store*....										
Total.....										

635

Agent.

* I have personally inspected and ascertained the accuracy of the quantities of oil stated to be remaining, prior to affixing my signature hereto.

List of stores wanting.

No. 14.—ENGLISH LIGHT-HOUSES.

Account of stores received, expended, and remaining in store, at the light, in the quarter ending

[28]

636

FOR REFLECTING LIGHTS.	Cotton wicks.	Balls of cotton.	Cylinders.	Polishing powder.	Cleaning-cloths for reflectors.	Cleaning-cloths for plate glass.	Skins.	Tow.	Wickholders.	Trimming scissors.	Powder for copper work.	Powder for brass work.	Woolen rubbers for copper work.	Woolen rubbers for brass work.	Bags of polishing powder.	Flexible brushes.
	Doz.	No.	Doz.	Oz.	Yds.	Yds.	No.	Lbs.	No.	No.	Lbs.	Lbs.	No.	No.	No.	No.
In store, per last return																
Received in this quarter																
Total																
Expended this quarter																
Remaining in store*																
Stores requested for the supply of the ensuing quarter																

* It is particularly requested that the agent will personally inspect and ascertain the accuracy of the quantities of each article stated to be in store prior to affixing his signature hereto.

Signed

Agent.

No. 15.—ENGLISH LIGHT-HOUSES.

Account of stores received, expended, and remaining in store at the light, in the quarter ending

FOR DIOPTRIC LIGHTS.	Concentric cotton wicks.	Argand cotton wicks.	Balls of cotton.	Large cylinders.	Polishing powder for lenses.	Cleaning cloths for lenses.	Cleaning cloths for plate glass.	Skins.	Tow.	Powder for brass work.	Powder for copper work.	Curved trimm'g scissors.	Spirits of wine.	Sponges.	Woolen rubbers for brass work.	Woolen rubbers for copper work.	Flexible brushes.	Curved brushes for lenses.
	Yds.	Doz.	No.	Doz.	Oz.	Yds.	Yds.	No.	Lbs.	Lbs.	Lbs.	No.	Qts.	No.	No.	No.	No.	No.
In store, per last return.....																		
Received in this quarter																		
Total.....																		
Expended this quarter.....																		
Remaining in store*																		
Stores requested for the supply of the ensuing quarter.....																		

* It is particularly requested that the agent will personally inspect and ascertain the accuracy of the quantities of each article stated to be in store prior to affixing his signature hereto.

Signed

Agent.

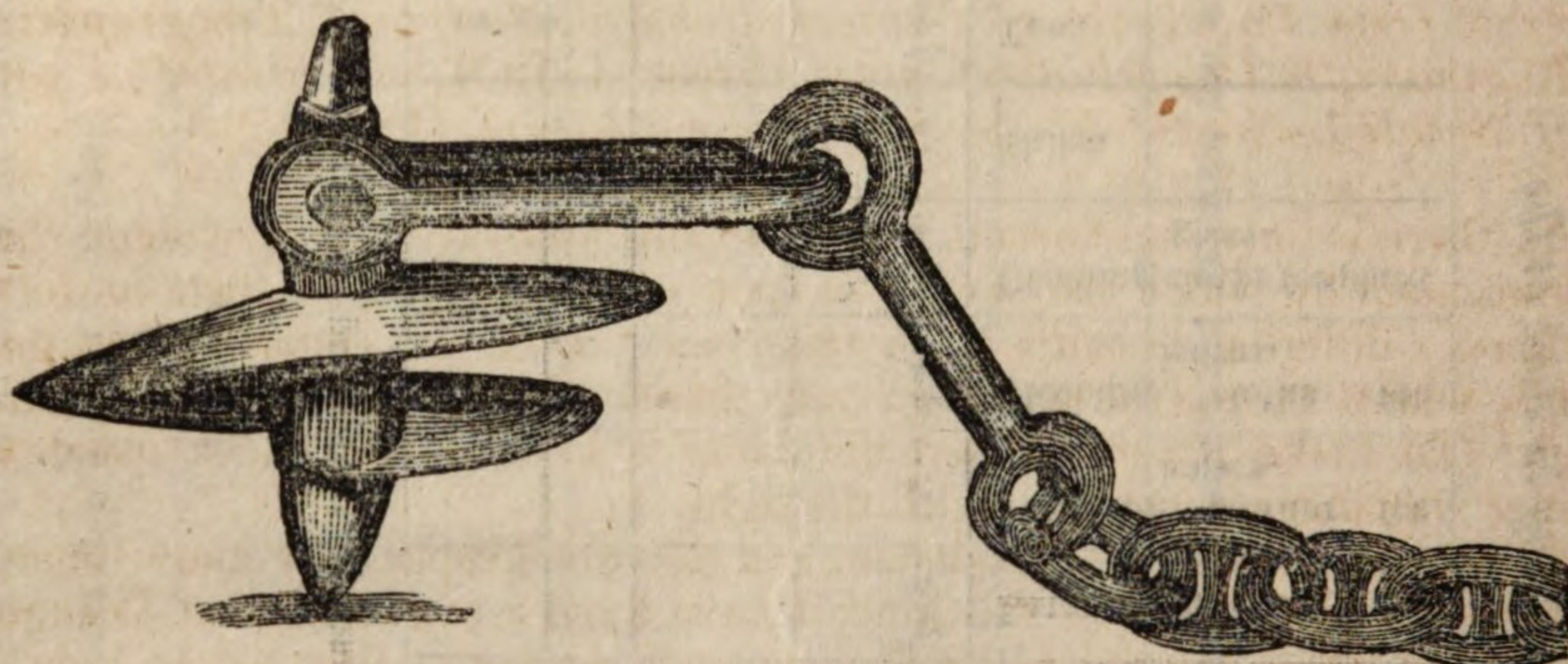
Mitchell's screw-piles and moorings.

SIRS: Permit us to present to your notice a brief description of our patent mooring, an instrument now well known in many of the principal ports and harbors of the United Kingdom, where they have been for a considerable time in constant use, and where, we may add, they have had the unqualified approbation of every scientific and nautical person who has had occasion to consider the subject.

The mooring is constructed (as its name implies) on the principle of the screw, but differing essentially in form from that well known instrument; for while the spiral thread makes little more than one turn round its shaft, it is, at the same time, extended to a very broad flange, the hold which it takes of the ground being proportional with its breadth of disk.

Where it is necessary to provide against a very heavy strain, we have hitherto used moorings of three feet six inches diameter, and the principle is capable of still further extension.

A mooring of the above diameter presents a resisting surface, equal to about ten square feet, whereas the palm of the largest anchor in the British navy does not exceed half that size; and some estimate of its holding power may be formed, when it is shown that this broad surface can be screwed to a depth many times greater than that to which the palm of an anchor can ever descend.



Patent screw mooring.

The method of laying down this mooring is briefly thus:

A strong mooring chain being so attached to it as to allow the screw to turn freely without carrying the chain round with it, a powerful iron shaft is then fixed firmly on the upper part of the mooring, which is formed square for that purpose, fitting in the same manner as the key to a watch in winding up: it is then lowered by the mooring chain, joint after joint being added to the shaft till the mooring has reached the ground. Eight levers of twelve feet in length are then applied to the shaft, in the manner of a capstan, when the operation of screwing the mooring into the ground commences.

Two boats or barges having been moored firmly, head and stern, close alongside each other, and the upright shaft rising between them about midships, the men place themselves at the bars or levers, and move round from one boat to the other, the two giving them a safe and convenient platform. By a simple contrivance, the levers are occasionally shifted upwards, as the screw and shaft sink into the ground.

When the number of men employed can no longer force the screw round, the levers are removed and the shaft drawn out of the ground, leaving the mooring firmly imbedded, with the chain attached to it: a buoy being shackled to the other end of the chain, the work is completed; the time required for the whole operation seldom exceeding a few hours.

These moorings have been placed in every description of ground—rock not excepted; and the qualities which entitle them to the patronage of the public are, perfect security to shipping, great economy, and an entire freedom from the many objections to which other moorings are liable. On these subjects, however, we shall not enlarge, but refer to the letters and testimonials hereto annexed, which have been selected from a great number of documents received on the subject.

Any communications addressed to Alexander Mitchell & Son, engineers, 2 Alfred street, Belfast, shall receive prompt attention.

We have the honor to be, sirs, your very obedient servants,

ALEXANDER MITCHELL & SON.

Lieuts. JENKINS and BACHE, U. S. N.

Extract from the report of Captain Canfield, Corps of Topographical Engineers, to Colonel Abert, dated October 1, 1851, and printed as part of Senate Document No. 1, of the present session, (1851-'52.)

As there is only one burner or lamp in this apparatus, it is evident that any accident by which the lamp was put out would leave them in total darkness; differing essentially in this respect from the common reflecting lights, where, if several lamps go out, there will still be a light of some kind. To make it certain that the lamp is kept burning, it is usual to keep a watchman constantly with the light.

As a substitute for the watchman, and that the keeper may know immediately of any accident of this kind, I have fixed a contrivance at Waughshance, by which the fog-bell will commence ringing as soon as the light is put out.

This is effected by making use of the expanding and contracting power of a copper tube, when heated and cooled. The tube is made to form a part of the chimney of the lamp.

The amount of the expansion under this heat is very small, (about one-twentieth of an inch.) But the expansive force being very great, I use a lever, with a short fulcrum running from the lamp at the centre to the side of the lantern, and increase the amount of the movement here ten times. To the end of this lever is attached a copper wire, which wire is also attached to another lever on the floor of the bell machine, forty feet below the lantern.

The movement by this second lever is again increased six times; so that the motion here amounts to full three inches.

This last lever, when the copper tube is heated by the lamp, is in a position to hold an iron hook, so that the hook will catch one of the spurs of the wheel which moves the clapper-shaft.

The catching of the spur, of course, stops the machine; when the light goes out, the copper tube of the chimney cools and contracts. The lever at the machine is raised, and the hook by its own weight swings clear of the spur

of the wheel, and the machine moves [on, and the bell rings; and, unless it is stopped, continues to ring until the machine runs down.

This arrangement is found to answer perfectly, and is tested every morning when the light is put out.

APPENDIX O—No. 1.

EXTRACTS FROM TREATISES ON LIGHT-HOUSE ILLUMINATIONS, &c., &c., &c.

Extracts from Mr. Alan Stevenson's treatise on light-houses, &c.

[John Weale, London, 1850.]

Colza oil has been introduced in England into all the lights, whether catoptric or dioptric; but in Scotland its general use has as yet been confined to the dioptric lights, and such catoptric lights as revolve, and are not likely to be changed to the dioptric system. In the catoptric lights, the only reason for not making an equally extensive trial is the necessity for renewing all the burners, which require to be so constructed as to receive thick wicks of brown cotton; and it has, until lately, been considered prudent to proceed with some caution in changing the apparatus, so as to suit it for burning a patent oil, the circumstances attending the regular and extensive supply and the price of which, can hardly yet be fully known. The change is proceeding gradually from the use of spermaceti to that of the colza oil; and, in a few seasons, the whole will be completed, as nearly all the revolving catoptric lights have been altered; and the change on the fixed lights has been only delayed until they shall be converted to the dioptric system, so that one change may serve every purpose at once. * *

Great as Argand's improvement undoubtedly was, the value of the lamp alone as a means for the illumination of light-houses must be regarded as comparatively small. The primary object of a light-house is, to give early notice to the mariner of his approach to the coast; and it is therefore necessary that the light be of such a kind that it may be seen at a great distance. Every one is practically acquainted with the fact that the rays proceed in all directions from a luminous body in straight lines; and if we could obtain a ball equally luminous in every part of its surface, it would give an equal share of light to every part of the inner surface of a hollow sphere, whose centre shall coincide with the centre of the ball. Again, if an opaque body were placed between the luminous ball and the hollow sphere, the part opposite that body would be deprived of the light by the interception of the rays, and no light would emerge from a hole bored in that part of the surface of the hollow sphere. The bearing of these facts is obvious; and no one can fail to perceive that in the case of a light-house illuminated by a single unassisted burner, a seaman could only receive the benefit of that small portion of light which emerges from the lamp in a line joining his eye and the centre of the flame. The other rays would be occupied partly, but in a very small proportion, in making the light visible in other parts of the horizon; while all the rest would be lost by escaping upwards into the sky, or downwards below the plane in which seamen can see a light-house. This state of matters would be little improved by increasing the number of burners, as the effective part of the light would only be augmented by the addition of an equally trifling portion of light from *each* burner. The small

pencils of rays thus meeting at the eye of a distant observer, would form a very minute fraction of the whole quantity of light uselessly escaping above and below the horizon, and also at the back of each flame; and the wasteful expenditure of light would be enormous. By such a method no practically efficient sea-light could ever have been obtained. * * *

The best proportions for paraboloidal mirrors depend on the objects which they are meant to attain. Those which are intended to give great divergence to the resultant beams, as in fixed lights, capable of illuminating the whole horizon at one time, should have a short focal distance; while those mirrors which are designed to produce a nearer approach to parallelism (as in the case of revolving lights, which illuminate but a few degrees of the horizon at any one instant of time) will have the opposite form. Those two objects may, no doubt, be attained with the same mirror, by increasing or diminishing the size of the burner; but that is by no means desirable, as any change in the size of a burner, which is found to be the best in other respects, must be considered as to some extent disadvantageous. * * *

The large mirrors used in the Northern light-houses have about twelve-seventeenths of the whole light of the lamp incident on their surface; the rest escapes in the comparatively useless state of naturally radiating light. Several arrangements have been proposed for economising this light, which will be afterwards noticed.

The reflectors used in the best light-houses are made of sheet-copper, plated in the proportion of six ounces of silver to sixteen ounces of copper. They are moulded to the paraboloidal form, by a delicate and laborious process of beating with mallets and hammers of various forms and materials, and are frequently tested during the operation by the application of a mould carefully formed. After being brought to the curve, they are stiffened round the edge by means of a strong bizzle, and a strap of brass which is attached to it for the purpose of preventing any accidental alteration of the figure of the reflector. Polishing powders are then applied, and the instrument receives its last finish. * * *

In light-houses of moderate height, the proper position for the reflector itself is perfect horizontality of its axis, which may be ascertained with sufficient accuracy, by trying with a plummet whether the lips of the instrument, which we may conclude to be at right angles to the plane of its axis, be truly vertical. In light-rooms very much elevated above the sea, however, the dip of the horizon becomes notable; and a slight inclination forwards should be given to the face of the reflectors, so that their axes produced may be tangents to the earth at the visible horizon of the light-room; an arrangement which, in practice, may be easily made by reflecting the sea horizon in a small mirror placed at the focus, and inclined at 45° to the axis of the paraboloid, so that the image of the sea-line may reach the eye in the line of the parameter in the same manner, as is afterwards noticed in speaking of the inclination of the curved mirrors used in addition to the refractors in certain dioptric fixed lights. This dip of the reflector, however, must not be permitted to interfere with the perfect horizontality of the top of the burner, which is indispensable to its proper burning. * * *

The effect of an annular lens, in combination with the great lamp, may be estimated at moderate distances to be nearly equal to that of between 3000 and 4000 Argand flames of about an inch diameter; that of a cylin-

dric refractor at about 250; and that of a curved mirror may perhaps on an average be assumed at about ten Argand flames.

The dioptric lights used in France are divided into six orders, in relation to their power and range; but in regard to their characteristic appearances, this division does not apply, as, in each of the orders, lights of identically the same character may be found, differing only in the distance at which they can be seen, and in the expense of their maintenance. The six orders may be briefly described as follows:—

1. Lights of the first order having an interior radius or focal distance of 36.22 inches (92^{cm.}), and lighted by a lamp of four concentric wicks, consuming five hundred and seventy gallons of oil per annum.

2. Lights of the second order having an interior radius of 27.55 inches (70^{cm.}), lighted by a lamp of three concentric wicks, consuming three hundred and eighty-four gallons of oil per annum.

3. Lights of the third order, lighted by a lamp of two concentric wicks, consuming one hundred and eighty-three gallons of oil per annum, and having a focal distance of 19.68 inches (50^{cm.})

4. Lights of the fourth order, or harbor-lights, having an internal radius of 9.84 inches (25^{cm.}), and a lamp of two concentric wicks, consuming about one hundred and thirty gallons of oil per annum.

5. Lights of the fifth order, having a focal distance of 7.28 inches (185^{cm.}); and

6. Lights of the sixth order, having an internal radius of 5.9 inches (15^{cm.}), and lighted by a lamp of one wick, or Argand burner, consuming forty-eight gallons of oil per annum. The more minute subdivisions of orders I consider to be unnecessary.

Those orders are not intended as distinctions; but are characteristic of the power and range of lights, which render them suitable for different localities on the coast, according to the distance at which they can be seen. This division, therefore, is analogous to that which separates our lights into *sea-lights*, *secondary lights*, and *harbor-lights*, terms which are used to designate the power and position, and not the appearance of the lights to which they are applied.

Each of the above orders is susceptible of certain combinations, which produce various appearances, and constitute the distinctions used for dioptric lights; but the following are those which have been actually employed as the most useful in practice:

The first order contains, first, lights producing, once in every minute, a great flash, preceded by a smaller one, by the revolution of eight great lenses and eight smaller ones combined with eight mirrors; second, lights flashing once in every half minute, and composed of sixteen half lenses. Those lights may have the subsidiary parts simply catoptric, or dia-catoptric; and third, fixed lights, composed of a combination of cylindric pieces, with curved mirrors or catadioptric zones ranged in tiers above and below them.

The second order comprises revolving lights with sixteen or twelve lenses, which make flashes every half-minute; and fixed lights varied by flashes once in every four minutes, an effect which, as already noticed, is produced by the revolution of exterior cylindric pieces.

The third order contains common fixed lights, and fixed lights varied by flashes once in every four minutes.

The fourth order contains simple fixed lights, and fixed lights varied by flashes once in three minutes.

The fifth order has fixed lights varied by flashes once in every three minutes, and fixed lights of the common kind. It has been thought necessary to change the term "fixed lights varied by flashes" for "fixed lights with short eclipses," because it has been found that at certain distances a momentary eclipse precedes the flash. The sixth order has only fixed lights.

These distinctions depend upon the periods of revolution rather than upon the *characteristic appearance* of the light; and therefore seem less calculated to strike the eye of a seaman than those employed on the coasts of Great Britain and Ireland. In conformity with this system, and in consideration of the great loss of light which results from the application of colored media, distinctions based upon color have been generally discarded in the French lights.

The distinctions are in fact only *four* in number, viz: Fixed; fixed, varied by flashes;* revolving, with flashes once a minute; and revolving with flashes every half-minute. To those might be added, revolving, with bright periods once in two minutes, and perhaps *flashing* once in *five seconds*, (as introduced by me at the Little Ross, but I cannot say with such complete success as would induce me to recommend its general adoption. My own experience would also lead me to reject the distinction called "fixed, varied by flashes," which I do not consider as possessing a marked or efficient character.

Having thus fully described the nature of the catoptric and dioptric modes of illuminating light-houses, I shall conclude with a comparative view of the merits of both systems, deduced from the experiments made at Gullan-hill during the winters of 1832 and 1833, under the inspection of the commissioners of Northern lights. The chief practical result of those trials was, that the light of one of the great annular lenses used in the revolving lights of the first order, was equal to the united effect of eight of the large reflectors employed in the revolving lights on the Scotch coast. It may be said, however, that the dia-catoptric† combination of pyramidal lenses and plane mirrors of Cordouan, adds the power of more than two reflectors to the effect of the great lens; but it ought to be remembered that in the French lights this additional power is used only to compensate for one of the defects of the system by lengthening the duration of the flash, and therefore contributes, if at all, only in a very indirect manner to render the light visible to the mariner at a greater distance. M. Fresnel found that from the smaller divergence of the lens the eclipses were too long and the bright periods of the revolution too short, and he therefore determined to adopt the horizontal deviation of 7° for the upper lenses, with a view to remedy this defect. Assuming, therefore, that it were required to increase the number of reflectors in a revolving light of three sides, so as to render it equal in power to a dioptric revolving light of the first order, it would be necessary to place eight reflectors on each face, so that the greatest number of reflectors required for this purpose may be taken at *twenty-four*. M. Fresnel has stated the expenditure of oil in the lamp of four concentric wicks at seven hundred and fifty grammes of colza oil per hour; and it is

* The "Feu fixe, varié par des éclats," or "Feu fixe, à courtes éclipses," of Fresnel.

† I use this word to designate the arrangement of pyramidal lenses and plane mirrors, by which the light is first *refracted* and then *reflected*.

found by experience at the Isle of May and Inchkeith that the quantity of spermaceti oil consumed by the great lamp is equal to that burned by from fourteen to sixteen of the Argand lamps used in the Scotch lights. It therefore follows that by dioptric means the consumption of oil necessary for between fourteen and sixteen reflectors will produce a light as powerful as that which would require the oil of twenty-four reflectors in the catoptric system of Scotland; and consequently that there is an excess of oil equal to that consumed by ten reflectors, or four hundred gallons in the year, against the Scotch system. But in order fully to compare the economy of producing two revolving lights of equal power by those two methods, it will be necessary to take into the calculation the interest of the first outlay in establishing them.

The expense of fitting up a revolving light with twenty-four reflectors, ranged on three faces, may be estimated at £1,298, and the annual maintenance, including the interest of the first cost of the apparatus, may be calculated at £418 8s. 4d. The fitting up a revolving light with eight lenses and the dia-catoptric accessory apparatus, may be estimated at £1,459, and the annual maintenance at £354 10s. 4d. It therefore follows that to establish and afterwards maintain a catoptric light of the kind called *revolving white*, with a frame of three faces, each equal in power to a face of the dioptric light of Cordouan, an annual outlay of £63 18s. more would be required for the reflecting light than for the lens light; while for a light of the kind called *revolving red and white*, whose frame has four faces, at least thirty-six reflectors would be required in order to make the light even approach an equality to that of Cordouan; and the catoptric light would in that case cost £225 more than the dioptric light.

The effect produced by burning an equal quantity of oil in revolving lights on either system may be estimated as follows: In a revolving light like that of Skerryvore, having eight sides, each lighting with its greatest power a horizontal sector of 4° , we have 32° (or *units*) of the horizon illuminated with the full power of three thousand two hundred Argand flames, and consequently an aggregate effect of one hundred and two thousand four hundred flames, produced by burning the oil required for *sixteen* reflectors; while in a catoptric apparatus, like that of the old light at Inchkeith, having seven sides of one reflector, each lighting with its greatest power a sector of $4^{\circ} 25'$, we have nearly 31° (or *units*) of the horizon illuminated with the full power of four hundred Argand flames, and consequently an aggregate effect of twelve thousand four hundred flames as the result of burning the oil required for *seven* reflectors. Hence the *effect* of burning the same quantity of oil in revolving lights on either system will be represented respectively by $\frac{16}{7} 12,400 = 28,343$ for

the catoptric, contrasted with 102,400 for the dioptric light; or, in other words, revolving lights on the dioptric principle use the oil more *economically* than those on the catoptric plan, nearly in the ratio of 3.6 to 1.

Let us now speak of fixed lights, to which the dioptric method is peculiarly well adapted. The effect produced by the consumption of a gallon of oil in a fixed light, with twenty-six reflectors, which is the smallest number that can be properly employed, may be estimated as follows:—The *mean* effect of the light spread over the horizontal sector, subtended by one reflector, as deduced from measurements made at each horizontal degree, by the method of shadows, is equal to 174 unassisted Argand burn-

ers. If, then, this quantity be multiplied by 360 degrees, we shall obtain an aggregate effect of 62,640, which, divided by 1040 (the number of gallons burned during a year in *twenty-six* reflectors,) would give sixty Argand flames for the effect of the light maintained throughout the year by the combustion of a gallon of oil. On the other hand, the power of a catadioptric light of the first order, like that lately established at Girdleness, may be estimated thus:—The *mean* effect of the light produced by the joint effect of both the dioptric and catadioptric parts of fixed light apparatus, may be valued at 450 Argand flames, which, multiplied by 360 degrees, gives an aggregate of 162,000; and if this quantity be divided by 570 (the number of gallons burned by the great flame in a year) we shall have about 284 Argand flames for the effect of the light produced by the combustion of a gallon of oil. It would thus appear that in fixed lights, the French apparatus, as lately improved, produces, as the *average* effect of the combustion of the same quantity of oil over the whole horizon, upwards of *four times* the amount of light that is obtained by the catoptric mode.

But the great superiority of the dioptric method chiefly rests upon its *perfect* fulfilment of an important condition required in a fixed light, by distributing the rays *equally* in every point of the horizon. In the event of the whole horizon not requiring to be illuminated, the dioptric light would lose a part of its superiority in economy, and when half the horizon only is lighted, it would be more expensive than the reflected light; but the greater power and more equal distribution of the light may be considered of so great importance, as far to outweigh the difference of expense. In the latter case, too, an additional power, as already noticed, can be given to the dioptric light, by placing at the landward side of the lightroom, spherical mirrors with their centres in the focus of the refracting apparatus.* The luminous cones, or pyramids, of which such reflectors would form the bases, instead of passing off uselessly to the land, would thus be thrown back through the focal point, and finally refracted, so as to increase the effect of the light seaward by nearly *one-third* of the light which would otherwise be lost.

The expense of establishing a fixed light composed of twenty-six reflectors, may be estimated at £950, and its annual maintenance, including interest on the first cost of the apparatus, may be reckoned at £425 10s.: and the expense of fitting up a fixed light on the dioptric principle with catadioptric zones is £1511, while its annual maintenance may be taken at £285 6s. 4d. It thus appears that the annual expenditure of dioptric fixed light is £140 3s. 8d. less than that of a fixed light composed of twenty-six reflectors; while the *average* effect, equally diffused over the horizon, is *four times* greater.

The comparative views already given of the catoptric and dioptric modes of illuminating light-houses, demonstrate that the latter produces more powerful lights by the combustion of the same quantity of oil; while it is obvious that the catoptric system insures a more certain exhibition of the light, from the fountain-lamps being less liable to derangement than the

*A similar arrangement can also be made in revolving lights by making the radius of the mirrors somewhat less than that of the inscribed circle of the octagon bounded by the lenses, so that they may circulate freely round the backs of the mirrors. The shortness of the radius of the reflecting surface would, of course, increase the divergence of the beam of light refracted through the lenses, as the flame would, in this case, subtend a greater angle at the face of the mirrors.

mechanical lamps used in dioptric lights. The balance, therefore, of real advantages or disadvantages, and consequently the propriety of adopting the one or the other system, involves a mixed question, not susceptible of a very precise solution, and leaving room for different decisions, according to the value which may be set upon obtaining a cheaper and better light on the one hand, as contrasted, on the other, with less certainty in its exhibition. Experience, however, goes far to show that, in practice, the risk of extinction of the lamp in dioptric lights is very small.

A few general considerations, serving briefly to recapitulate the arguments for and against the two systems, may not be out of place. And, first, regarding the fitness of dioptric instruments for revolving lights, it appears from the details above given—

1. That by placing eight reflectors on each face of a revolving frame, a light might be obtained as brilliant as that derived from the great annular lens; and that, in the case of a frame of three sides, the excess of expense by the reflecting mode would be £63 18s.; and in the case of a frame of four sides, the excess would amount to £225.

2. That for burning oil economically in revolving light-houses, which illuminate every point of the horizon successively, the lens is more advantageous than the reflector in the ratio of 3.6 to 1.

3. That the divergence of the rays from the lens being less than from the reflector, it becomes difficult to produce, by lenses, the appearance which characterises the catoptric revolving lights, already so well known to British mariners; and any change of existing lights which would, of course, affect their appearance, must, therefore, involve some practical objections, which do not at all apply to the case of new lights.

4. That the uncertainty in the management of the lamp renders it more difficult to maintain the revolving dioptric lights without risk of extinction, an accident which has several times occurred at Cordouan and other light-houses, both in France and elsewhere. A more extended experience, however, has tended to moderate any fears on this head.

5. That the extinction of one lamp in a revolving catoptric light is not only less probable, but leads to much less serious consequences than the extinction of the single lamp in a dioptric light; because, in the first case, the evil is limited to diminishing the power of *one face* by an *eighth* part; whilst, in the second, the *whole horizon is totally deprived of light*. The extinction of a lamp, therefore, in a dioptric light, leads to evils which may be considered *very great* in comparison with the consequences which attend the same accident in a catoptric light.

In comparing the fixed dioptric and the fixed catoptric apparatus, the results may be summed up under the following heads:

1. It is impossible, by means of any practicable combination of paraboloidal reflectors, to distribute round the horizon a zone of light of exactly *equal intensity*; while this may be easily effected by dioptric means, in the manner already described. In other words, the qualities required in fixed lights cannot be so fully obtained by reflectors as by refractors.

2. The *average* light produced in every azimuth by burning one gallon of oil in Argand lamps, with reflectors, is only about *one-fourth* of that produced by burning the same quantity in the dioptric apparatus; and the annual expenditure is £140 3s. 8d. less for the entire dioptric light than for the catoptric light.

3. The *characteristic* appearance of the fixed reflecting light in any one

azimuth would not be changed by the adoption of the dioptric method, although its increased *mean* power would render it visible at a greater distance in every direction.

4. From the equal distribution of the rays, the dioptric light would be observed at equal distances in every point of the horizon; an effect which cannot be fully attained by any practicable combination of paraboloidal reflectors.

5. The inconveniences arising from the uncertainty which attends the use of the mechanical lamp, are not perhaps so much felt in a fixed as in a revolving light; because the greater simplicity of the apparatus admits of easier access to it in case of accident.

6. But the extinction of a lamp in a catoptric light, leaves only one *twenty-sixth part* of the horizon without the benefit of the light, and the chance of accident arising to vessels from it, may, therefore, be considered as incalculably less than the danger resulting from the extinction of the single lamp of the dioptric light, which deprives the whole horizon of light.

7. There is also, in certain situations, a risk arising from irregularity in the distances at which the same fixed catoptric light can be seen in the different azimuths. This defect, of course, does not exist in the dioptric light.

There can be little doubt that the more fully the system of Fresnel is understood, the more certainly will it be preferred to the catoptric system of illuminating light-houses, at least in those countries where this important branch of administration is conducted with the care and solicitude which it deserves.

It must not, however, be imagined, that there are no circumstances in which the catoptric system is not absolutely preferable to illumination by means of lenses. We have hitherto attended only to horizontal divergence and its effects, and this is unquestionably the more important view; but the consideration of vertical divergence must not be altogether overlooked. Now while it is obvious that vertical divergence, at least above the horizon, involves a total loss of the light which escapes uselessly upwards into space, (in which respect the reflectors are much less advantageous,) it is no less true, that if the sheet of light which reaches the most distant horizon of the light-house, however brilliant, were as *thin* as the absence of all vertical divergence would imply, it would be practically useless; and some measure of dispersion in the arc *below* the horizon is therefore absolutely indispensable to constitute a really useful light. In the reflector, the greatest vertical divergence below the horizontal plane of the focus is $16^{\circ} 8'$, and that of the lens is about $4^{\circ} 30'$. Let us consider for a moment the bearing of those facts upon the application of the two modes of illumination to special circumstances. The powerful beam of light transmitted by the lens, peculiarly fits that instrument for the great sea-lights which are intended to warn the mariner of his approach to a distant coast which he first makes on an *over-sea* voyage; and the deficiency of its divergence, whether horizontal or vertical, is not practically felt as an inconvenience in lights of that character, which seldom require to serve the double purpose of being visible at a great distance, and at the same time of acting as guides for danger near the shore. For such purposes, the lens applies the light much more advantageously as well as more economically than the reflector; because, while the duration of its *least* divergent beam is nearly equal to that of the reflector, it is *eight* times more powerful. A revolving system of eight lenses illuminates an horizontal arc of 32° with this bright beam,

The reflector, on the other hand, spreads the light over a larger arc of the horizon; and, while its *least* divergent beam is much less powerful than that of the lens, the light which is shed over its *extreme* arc is so feeble as to be practically of no use in lights of extensive range, even during clear weather. When a light-house is placed on a very high headland, however, the deficiency of divergence in the vertical direction is often found to be productive of some practical inconvenience; but this defect may be partially remedied by giving to the lenses a slight inclination *outwards* from the vertical plane of the focus, so as to cause the most brilliant portion of the emergent beam to reach the *visible horizon* which is due to the height of the lantern. It may be observed, also, that a lantern at the height of 150 feet, which (taking into account the common height of the observer's eye at sea) commands a range of upwards of twenty English miles, is sufficient for all the ordinary purposes of the navigator, and that the intermediate space is practically easily illuminated, even to within a mile of the light-house, by means of a slight inclination of the subsidiary mirrors, even where the light from the principal part of the apparatus passes over the seaman's head. For the purpose of leading lights, in narrow channels, on the other hand, and for the illumination of certain narrow seas, there can be no doubt that reflectors are much more suitable and convenient. In such cases, the amount of vertical divergence below the horizon forms an important element in the question, because it is absolutely necessary that the mariner should keep sight of the lights even when he is very near them; while there is not the same call for a very powerful beam which exists in the case of sea-lights. Yet even in narrow seas, where low towers, corresponding to the extent of the *range* of the light, are adopted, but where it is, at the same time, needful to illuminate the whole or the greater part of the horizon, the use of dioptric instruments will be found almost unavoidable, especially in fixed lights, as well from their equalizing the distribution of the light in every azimuth, as from their much greater economy in situations where a large annual expenditure would often be disproportionate to the revenue at disposal. In such places, where certain peculiarities of the situation require the combination of a light equally diffused over the greater portion of the horizon, along with a greater vertical divergence in certain azimuths, than dioptric instruments afford, I have found it convenient and economical to add to the fixed refracting apparatus a single paraboloidal reflector, in order to produce the desired effect, instead of adapting the whole to the more expensive plan for the sake of meeting the wants of a single narrow sector of its range. In other cases, where the whole horizon is to be illuminated, and great vertical divergence is at the same time desirable, a slight elevation of the burner, at the expense, no doubt, of a small loss of light, is sometimes resorted to, and is found to produce, with good effect, the requisite depression of the emergent rays.

In certain situations, where a great range, and, consequently, a powerful light must be combined with tolerably powerful illumination in the immediate vicinity of the light-house, we might, perhaps, advantageously adopt a variation of the form and dimensions of the mirrors employed, so as to resemble those formerly used at the Tour de Cordouan, which were of considerably larger surface and longer focal distance than those which are used in Britain. If such a form were adopted, the power of the light for the purpose of the distant range would be increased; and I would propose to compensate for the deficiency of divergence consequent on a long focal dis-

tance, by placing a second burner in some position between the parameter and the vertex, and slightly elevated above the axis of the instrument, so as to throw the greater portion of the beam resulting from this second burner below the horizontal plane of the focus. Such an expedient is no doubt somewhat clumsy, and would at the same time involve the consumption of twice the quantity of oil used in an ordinary catoptric light; but I can still conceive it to be preferable, in certain situations, to the use of lenses alone.

Thus it appears that we must not too absolutely conclude against one, or in favor of the other mode of illumination for light-houses; but, as in every other department of the arts, we shall find the necessity of patiently weighing all the circumstances of each particular case that comes before us, before selecting that instrument, or combination of instruments, which appears most suitable.

The mode of distinguishing lights in the system of Fresnel depends more upon their *magnitude* and the *measured interval* of the time of their revolution, than upon their *appearance*; and no other very marked distinctions, except fixed and revolving, have been successfully attempted in France. As above stated, I consider the distinction of the *fixed light varied by flashes*, to possess an appearance too slightly differing from that of a revolving light to admit of its being safely adopted in situations where revolving lights are near. The trial which I made at the Little Ross, in the Solway Frith, of producing, by means of lenses, a light flashing once in five seconds of time, although successful so far as mere distinction is concerned, has several practical defects, arising from the shortness of the duration of the flashes compared with the powerful effect of the fixed part of the apparatus, which I consider sufficient to prevent its adoption in future, especially considering that a much more marked appearance can be produced by means of reflectors, as has been done at the Buchanness in Aberdeenshire, and the Rhinns of Islay in Argyleshire. Colored media have never, so far as I know, been applied to dioptric apparatus, except in the case of the Maplin light at the mouth of the Thames, and Cromarty Point light at the entrance to the Cromarty Frith, Nosshead in Caithness, and Ship Rock of Sanda in Argyleshire, but in all those instances successfully. In the case of the fixed light at Sanda, in particular, I would observe that it is seen at the distance of sixteen nautical miles, and occasionally observed even so far off as twenty-two nautical miles. The enormous loss of light, however, amounting to no less than 0.80 of the whole incident rays, forms a great bar to the adoption of color as a distinction; and any means which could tend to lessen that absorption, and at the same time produce the characteristic appearance, would be most valuable. I have tried some glasses of a pink tinge, prepared by M. Letourneau of Paris, in which the absorption does not exceed 0.57 of the incident rays; but the appearance of the light, at a distance, is much less marked than that produced by the glasses used in Britain. Such deficiency of characteristic color might lead to serious consequences, as the transmission of white rays, through a hazy atmosphere, too often produces, by absorption, a reddish tinge of the light, for which the less marked appearance given by the paler media might be easily mistaken. This coloring power of absorption is so well known, that red lights are seldom used except in direct contrast with white ones; but, on a coast so thickly studded with light-houses as that of Great Britain, the number of distinctions is insufficient to supply all our wants, so that we

are sometimes reluctantly compelled to adopt a *single red light* in some situation of lesser importance, or which, from some local circumstances and the appearance of the lights which must be seen by the mariner before passing it, is not likely to be mistaken for any other. The great loss of light by colored media causes the red beam, in a revolving light, to be seen at a shorter distance than the white; and it is conceivable that, in certain circumstances, this might lead the mariner to mistake a *red and white light* for a *white* light revolving at half the velocity. Such a mistake might perhaps prove dangerous; but the lights are generally so situated that there is ample time for the mariner, after first discovering the red light, and thus correcting any mistake, to shape his course accordingly. All other colored media except *red* have been found useless as distinctions for any lights of extensive range, and fail to be efficient, owing to the necessity of absorbing almost all the light before a marked appearance can be obtained. In a few pier or ferry lights, green and blue media have been tried, and found available at the distance of a few cables' lengths.*

It seems to be a natural consequence of the physical distribution of light, that fixed lights, which illuminate the whole horizon, should be less powerful than revolving lights which have their effect concentrated within narrow sectors of the horizon. Any attempt to increase the power of fixed lights is, therefore, worthy of attention; and when the late Captain Basil Hall proposed a plan for effecting this object, it received, as it deserved, the full consideration of the Scotch light-house board, who authorized me to repeat Captain Hall's experiments, and verify his results by observations made at a considerable distance.

The familiar experiment of whirling a burning stick quickly round the head, so as to produce a ribbon of light, proves the possibility of causing a continuous impression on the retina by intermittent images succeeding each other with a certain rapidity. From the moderate velocity at which this continuity of impression is obtained, we should be warranted in concluding, *a priori*, that the time required to make an impression on the retina is considerably less than the duration of the impression itself; for the continuity of effect must, of course, be caused by fresh impulses succeeding each other before the preceding ones have entirely faded. If it were otherwise, and the time required to make the impression were equal to the duration of the sensation, it would obviously be impossible to obtain a series of impulses so close or continuous in their effects as to run into and overlap each other, and thus throw out the intervals of darkness; because the same velocity which would tend to shorten the dark intervals, would also curtail the bright flashes, and thus prevent their acting on the eye long enough to cause an impression. Accordingly, we find that the duration of an impression is in reality much greater than the time required for producing the effect on the retina. It is stated by Professor Wheatstone, in the London Transactions for 1834, that only about *one millionth part* of a second is required for making a distinct impression on the eye; and it appears from a statement made by Lamé, at p. 425 of his *Cours de Physique*, that M. Plateau found that an impression on the retina preserved its intensity unabated during *one hundredth* of a second, so that, however small those times may be in themselves, the one is 10,000 greater than the other.

* In some late experiments which I made with very powerful instruments, green lights were visible in very clear weather, at the distance of seven miles. The blue could only once be seen, with great difficulty, at five miles.

It has been ascertained, by direct experiment,* that the eye can receive a fresh impression before the preceding one has faded; and, indeed, if this were impossible, absolute continuity of impression from any succession of impulses, however rapid, would seem to be unattainable; and the approach to perfect continuity would be inversely as the time required to make an impression.

From the property which bright bodies passing rapidly before the eye possess of communicating a continuous impression to the sense of sight, the late Captain Basil Hall conceived the idea, not merely of obtaining all the effects of a fixed light, by causing a system of lenses to revolve with such a velocity as to produce a continuous impression, but, at the same time, of obtaining a much more brilliant appearance, by the compensating influence of the bright flashes, which he expected would produce impulses sufficiently powerful and durable to make the deficiency of light in the dark spaces almost imperceptible. The mean effect of the whole series of changes would, he imagined, be thus greatly superior to that which can be obtained from the same quantity of light equally distributed, as in fixed lights, over the whole horizon. Now this expectation, if it be considered solely in reference to the physical distribution of the light, involves various difficulties. The quantity of light subjected to instrumental action is the same whether we employ the refracting zones at present used in fixed dioptric lights, or attempt to obtain continuity of effect by the rapid revolution of lenses; and the only difference in the action of those two arrangements is this, that while the zones distribute the light equally over the whole horizon, or rather do not interfere with its natural horizontal distribution, the effect of the proposed method is to collect the light into pencils, which are made to revolve with such rapidity that the impression from each pencil succeeds the preceding one in time to prevent a sensible occurrence of darkness. To expect that the mean effect of the light, so applied, should be greater than when it is left to its natural horizontal divergence, certainly appears at first to involve something approaching to a contradiction of physical laws. In both cases, the same quantity of light is acted upon by the instrument; and, in either case, any one observer will receive an impression similar and equal to that received by any other stationed at a different part of the horizon; so that, unless we imagine that there is some loss of light peculiar to one of the methods, we are shut up, in the physical view of the question, to the conclusion that the impressions received by each class of observers must be of equal intensity. In other words, the same quantity of light is by both methods employed to convey a continuous impression to the senses of spectators in every direction, and, in both methods, equality of distribution is effected, since it does not at all consist with our hypothesis, that any one observer in the same class should receive more or less than his equal share of the light. Then, as to the probability of the loss of light, it seems natural to expect that this should occur in connection with the revolving system, because the velocity is an extraneous circumstance, by no means necessary to an equal distribution of the light, which can, as we already know, be more naturally, and at the same time perfectly attained by the use of the zones.

On the other hand, it must not be forgotten that, although the effect of

* Lamé, Cours de Physique, p. 424. "L'impression peut subsister encore lorsque la suivante a lieu."

both methods is to give each part of the horizon an equal share of light, there is yet this difference between them, that while the light from the zones is equally intense at every instant of time, that evolved by the rapidly circulating lenses is constantly passing through every phase between total darkness and the brightest flash of the lens; and this difference, taken in connection with some curious physiological observations regarding the sensibility of the retina, gives considerable countenance to the expectation on which Captain Hall's ingenious expedient is based. The fact which has already been noticed, and which the beautiful experiments of M. Plateau and Professor Wheatstone have of late rendered more precise, that the duration of an impression on the retina is not only appreciable, but is much greater than the time required to cause it, seems to encourage us in expecting that, while the velocity required to produce continuity of effect would not be found so great as to interfere with the formation of a full impression, the duration of the impulse from each flash would remain unaltered, and the dark intervals which do not excite the retina would, at the same time, be shortened; and that, therefore, we might in this manner obtain an effect on the senses exceeding the brilliancy of a steady light distributed equally in every direction by the ordinary method. Some persons, indeed, who have speculated on this subject, seem even to be of opinion that, so far from the whole effect of the series of continuous impressions being weakened by a blending of the dark with the bright intervals, the eye would in reality be stimulated by the contrast of light and darkness, so as thereby to receive a more complete and durable impulse from the light. It is obvious, however, that this question regarding the probable effect to be anticipated from a revolution so rapid as to cause a continuous impression, could only have been satisfactorily answered by an appeal to experiment.

In experimenting on this subject, I used the apparatus formerly employed by Captain Hall. It consisted of an octagonal frame, which carried eight of the discs that compose the central part of Fresnel's compound lens, and was susceptible of being revolved slowly or quickly at pleasure, by means of a crank handle and some intermediate gearing. The experiments were nearly identical with those made by Captain Hall, who contrasted the effect of a single lens at rest, or moving very slowly, with that produced by the eight lenses, revolving with such velocity as to cause an apparently continuous impression on the eye. To this experiment I added that of comparing the beam thrown out by the central portion of a cylindric refractor, such as is used at the fixed light of the Isle of May, with the continuous impression obtained by the rapid revolution of the lenses. Captain Hall made all his comparisons at the short distance of one hundred yards; and, in order to obtain some measure of the intensity, he viewed the lights through plates of colored glass until the luminous discs became invisible to the eye. I repeated those experiments at Gullan, under similar circumstances, but with very different results. I shall not, however, enter upon the discussion of those differences here, although they are susceptible of explanation, and are corroborative of the conclusions at which I arrived, by comparing the lights from a distance of fourteen miles; but shall briefly notice the more important results which were obtained by the distant view. They are as follows:

1. The flash of the lens revolving slowly was very much larger than that of the rapidly revolving series; and this decrease of size in the luminous object presented to the eye became more marked as the rate of revolution

was accelerated, so that, at the velocity of eight or ten flashes in a second, the naked eye could hardly detect it, and only few of the observers saw it, while the steady light from the fixed refractor was distinctly visible.

2. There was also a marked falling off in the brilliancy of the rapid flashes as compared with that of the slow ones; but this effect was by no means so striking as the decrease of volume.

3. Continuity of impression was not attained at the rate of five flashes in a second, but each flash appeared to be distinctly separated by an interval of darkness; and even when the nearest approach to continuity was made, by the recurrence of eight or ten flashes in a second, the light still presented a twinkling appearance, which was well contrasted with the steady and unchanging effect of the cylindric refractor.

4. The light of the cylindric refractor was, as already stated, steady and unchanging, and of much larger volume than the rapidly revolving flashes. It did not, however, appear so brilliant as the flashes of the quickly revolving lenses, more especially at the lower rate of five flashes in a second.

5. When viewed through a telescope, the difference of volume between the light of a cylindric refractor and that produced by the lenses at their greatest velocity was very striking. The former presented a large diffuse object of inferior brilliancy, while the latter exhibited a sharp pin-point of brilliant light.

Upon a careful consideration of these facts, it appears warrantable to draw the following general conclusions:

1. That our expectations as to the effects of light, when distributed according to the law of its natural horizontal divergence, are supported by observed facts as to the visibility of such lights, contrasted with those whose continuity of effect is produced by collecting the whole light into bright pencils, and causing them to revolve with great velocity.

2. It appears that this deficiency of visibility seems to be chiefly due to a want of volume in the luminous object, and also, although in a less degree, to a loss of intensity, both of which defects appear to increase in proportion as the motion of the luminous object is accelerated.

3. That this deficiency of volume is the most remarkable optical phenomenon connected with the rapid motion of luminous bodies, and that it appears to be directly proportional to the velocity of their passage over the eye.

4. That there is reason to suspect that the visibility of distant light depends on the volume of the impression in a greater degree than has perhaps been generally imagined.

5. That, as the size and intensity of the radiants causing these various impressions to a distant observer were the same, the volume of the light, and, consequently, *cæteris paribus*, its visibility, are, within certain limits, proportionate to the time during which the object is present to the eye.

Such appear to be the general conclusions which those experiments warrant us in drawing; and the practical result, in so far as light-houses are concerned, is sufficient to discourage us from attempting to improve the visibility of fixed lights in the manner proposed by Captain Hall, even supposing the practical difficulties connected with the great centrifugal force generated by the rapid revolution of the lenses to be less than they really are.

The decrease in the volume of the luminous object caused by the rapid motion of the lights is interesting from its apparent connection with the

curious phenomenon of irradiation. When luminous bodies, such as the lights of distant lamps, are seen by night, they appear much larger than they would do by day; and this effect is said to be produced by irradiation. M. Plateau, in his elaborate essay on this subject, after a careful examination of all the theories of irradiation, states it to be his opinion, that the most probable mode of accounting for the various observed phenomena of irradiation is to suppose, that, in the case of a night-view, the excitement caused by light is propagated over the retina beyond the limits of the day-image of the object, owing to the increased stimulus produced by the contrast of light and darkness; and he also lays it down as a law, confirmed by numerous experiments, that irradiation increases with the duration of the observation. It appears, therefore, not unreasonable to conjecture, that the deficiency of volume observed during the rapid revolution of the lenses may have been caused by the light being present to the eye so short a time, that the retina was not stimulated in a degree sufficient to produce the amount of irradiation required for causing a large visual object. When, indeed, the statement of M. Plateau, that irradiation is proportional to the duration of the observation, is taken in connection with the observed fact, that the volume of the light decreased as the motion of the lenses was accelerated, it seems almost impossible to avoid connecting together the two phenomena as cause and effect.

Before leaving this part of the subject, I will call attention to some late plans for combining dioptric and catoptric apparatus, the object of which is to subject to the corrective action of instruments, a greater proportion of the luminous sphere than it has yet been found practicable to do, especially in revolving lights. Reflectors act chiefly on the *posterior* portion of the flame, and generally receive about *twelve-seventeenths* of the whole luminous sphere; while a series of dioptric instruments can only affect an *anterior zone*, amounting to about two-fifths of the whole light which is emitted by the lamp. Certain deductions due to the form of the lower part of the burners, and to the loss of light at reflection, which is not less than *one-half* of the incident light, as well as to that by refraction through the lens, (which, however, cannot exceed *one-tenth* of the incident light,) will reduce those numbers from twelve-seventeenths to one-third, and from two-fifths to three-tenths, thus making the ratio of the proportion of the whole flame *actually given forth* by the reflectors to the amount by lenses equal to that of ten to nine. In fixed lights, on Fresnel's system, we have already seen that nearly the whole of the available light is turned to a useful purpose by means of the curved mirrors or catadioptric zones, which are added to increase the effect of the central dioptric belt; and, in revolving lights, an approximation to a similar result is obtained by the addition of the dia-catoptric combination of pyramidal lenses and plane mirrors placed above the great lenses. Catoptric lights, however, to which such auxiliary arrangements are inapplicable, had still the great disadvantage of leaving the *anterior cone* of light to pass off in the useless state of naturally divergent light; and anything calculated to increase the power of that class of lights, without altering that simplicity and security of the burners employed in them, which renders them so suitable for remote situations in the colonies, deserves careful attention. It will be remembered that the proposal of Mr. Barlow for effecting this object, has already been noticed; and it is needless now to do more than remind the reader that the practical disadvantage of the great aberration in the path of the rays reflected from the

subsidiary hemispherical mirror, which must necessarily be of very small dimensions, together with the great loss of light by the second reflection, must go far to neutralize the effect of Mr. Barlow's plan. A combination of dioptric and catoptric instruments, intended to produce a similar effect, has been proposed by Mr. Alexander Gordon, and is described at page 385 of the tenth volume of the *Civil Engineers' and Architects' Journal*. It consists of a paraboloidal mirror, of a very short focal distance, with some of the outer zones of one of Fresnel's smaller lenses in front of it. The zones are intended to refract some of the rays that escape past the edges of the mirror, while the pencil of light reflected from the mirror itself is supposed to pass through the circular space which is generally occupied by the central portion of the lens. This arrangement is a step in the right direction, only in so far as it implies the union of the two modes of illumination; but, as it is by no means skilfully designed, it is liable to several palpable objections.

1. The actual gain of light has been greatly overrated by the writer in the *Journal*, who expects to turn twenty-seven-twenty-eighths of the whole light to a useful account; but so great a gain of light can never consist with the form and position of the lower part of the flame.

2. Upwards of twenty-four-twenty-eighths of the estimated quantity would be intercepted by the paraboloid alone, and little more than twenty-eighths by the rings of the lens, an addition far too insignificant to warrant the adoption of so expensive an appendage to the reflector.

3. The great aberration of the rays reflected by the conoid behind the parameter, and its small reflecting surface, must render it practically useless; and, perhaps, nearly *one-half* of the whole light would thus be lost to the mariner. The accurate formation of a paraboloid of such depth would also be difficult; and, considering the practical inutility of the conoid behind the parameter, would seem to be a misapplication of labor.

4. The union of such an instrument with the lenticular zones in front, which require that the pencil of parallel rays should be reflected with the greatest accuracy, so as to enable them to pass through the circular space bounded by the zones, is an obvious misapplication of a paraboloid with a short focal distance, to a purpose for which it is singularly unsuitable.

5. Mirrors somewhat of the same form were in use at Scilly light-house, and were long ago discarded as disadvantageous, at the suggestion of the late eminent Captain Huddart.

6. The outer zones, which form the *least efficient*, and at the same time the *most expensive* portion of the compound lens have been preferred to the central portion of that instrument: and by this means the anterior cone of rays is at the same time lost.

* * * * *

A considerable practical defect in all the light-house lanterns which I have ever seen, with the exception of those recently constructed for the Scotch light-houses, consists in the vertical direction of the astragals, which of course tend to intercept the whole or a great part of the light in the azimuth which they subtend. The consideration of the improvement which I had effected in giving a diagonal direction to the joints of the fixed refractors first led me to adopt a diagonal arrangement of the framework which carries the cupola of zones, and afterwards for the astragals of the lantern. Not only is the *direction* of the astragals more advantageous for equalizing the effect of the light, but the greater stiffness and strength which

such an arrangement gives to the framework of the lantern, make it safe to use more slender bars, and thus also absolutely *less* light is intercepted; the panes of glass at the same time become triangular, and are necessarily stronger than rectangular panes of equal surface. This form of lantern is extremely light and elegant, and is shown, with detailed drawings of some of its principal parts, in plate X. To avoid the necessity of painting; which, in situations so exposed as those which light-houses generally occupy; is attended with many inconveniences and no small risk; the framework of the lantern is now formed of gun-metal and the dome is of copper. A lantern for a light of the first order, twelve feet in diameter, and with glass frames ten feet high, costs, when glazed, about £1260. In order to give the light-keepers free access to cleanse and wash the upper panes of the lantern, (an operation which in snowy weather must sometimes be frequently repeated during the night,) a narrow gangway, on which they may safely stand, is placed on the level of the top of the lower panes, and at the top of the second panes rings are provided of which the light-keepers may lay hold for security in stormy weather. A light trap-ladder is also attached to the outside of the lantern by means of which there is an easy access to the ventilator on the dome.

Great care is bestowed on the glazing of the lantern, in order that it may be quite impervious to water, even during the heavy gales. When iron is used for the frames, they are carefully and frequently painted; but gun-metal, as just noticed, is now generally used in the Scotch light-houses. There is great risk of the glass plates being broken by the shaking of the lantern during high winds; and as much as possible to prevent this, various precautions are adopted. The arris of each plate is always carefully rounded by grinding; and grooves about half an inch wide, capable of holding a good thickness of putty, are provided in the astragals for receiving the glass, which is quarter of an inch thick. Small pieces of lead or wood are inserted between the frames and the plates of glass against which they may press, and by which they are completely separated from the more unyielding material of which the lantern-frames are composed. Panes glazed in frames padded with cushions, and capable of being temporarily fixed in a few minutes, in the room of a broken plate, are kept ready for use in the store-room. Those framed plates are called *storm panes*, and have been found very useful on several occasions when the glass has been shattered by large sea-birds coming against it in a stormy night, or by small stones violently driven against the lantern by the force of the wind.

The ventilation of the lanterns forms a most important element in the preservation of a good and sufficient light. An ill-ventilated lantern has its sides continually covered with the water of condensation, which is produced by the contact of the ascending current of heated air; and the glass, thus obscured, obstructs the passage of the rays and diminishes the power of the light. In the northern light-houses, ventilators, capable of being opened and shut at pleasure, so as to admit from without a supply of air when required, are provided in the parapet wall on which the lantern stands; the lantern roof also is surmounted by a cover which, while it closes the top of an open cylindric tube against the entrance of rain, and descends over it only so far as is needful for that purpose, still leaves an open air-space between it and the dome. This arrangement permits the current of heated air, which is continually flowing from the lantern through the cylindric tube, to pass between it and the outer cover, from which it finally escapes to the

open air through the space between the cover and the dome. The door which communicates from the light-room through the parapet to the balcony outside, is also made the means of ventilating the light-room; and, for that purpose, it is provided with a sliding bolt at the bottom, which, being dropped into one or other of the holes cut in the balcony for its reception, serves to keep the door open at any angle that may be found necessary. A useful precaution was introduced by my predecessor, as engineer to the Northern lights board, in order to prevent the too rapid condensation of heated air on the large internal surface of the lantern roof, which consists in having two domes with an air-space between them, as shown in the enlarged diagrams in plate X.

An important improvement in the ventilation of light-houses was, some years ago, introduced by Dr. Faraday into several of the light-houses belonging to the Trinity House, and has since been adopted in all the dioptric lights belonging to the commissioners of Northern light-houses. After mentioning several proofs of extremely bad ventilation in light-houses, Dr. Faraday thus describes his apparatus:*

“The ventilating pipe or chimney is a copper tube, four inches in diameter, not, however, in one length, but divided into three or four pieces; the lower end of each of these pieces for about one and a half inch is opened out into a conical form, about five and a half inches in diameter at the lowest part. When the chimney is put together, the upper end of the bottom piece is inserted about half an inch into the cone of the next piece above, and fixed there by three ties or pins, so that the two pieces are firmly held together; but there is still plenty of air-way or entrance into the chimney between them. The same arrangement holds good with each succeeding piece. When the ventilating chimney is fixed in its place, it is adjusted so that the lamp-chimney enters about half an inch into the lower cone, and the top of the ventilating chimney enters into the cowl or head of the lantern.

“With this arrangement, it is found that the action of the ventilating flue is to carry up every portion of the products of combustion into the cowl; none passes by the cone apertures into the air of the lantern, but a portion of the air passes from the lantern by these apertures into the flue, and so the lantern itself is in some degree ventilated.

“The important use of these cone apertures is, that when a sudden gust or eddy of wind strikes into the cowl of the lantern, it should not have any effect in disturbing or altering the flame. It is found that the wind may blow suddenly in at the cowl, and the effect never reaches the lamp. The upper, or the second, or the third, or even the fourth portion of the ventilating flue might be entirely closed, yet without altering the flame. The cone junctions in no way interfere with the tube in carrying up all the products of combustion; but if any downward current occurs, they dispose of the whole of it into the room without ever affecting the lamp. The ventilating flue is in fact a tube, which, as regards the lamp, can carry everything *up* but conveys nothing *down*.”

The advantages of this arrangement, as applied to the Northern light-houses, were much less palpable than those which are described in the beginning of Dr. Faraday's paper, because their ventilation was very good before its introduction; and the flame in particular was perfectly steady,

* Minutes of Institution of Civil Engineers, vol. i., p. 207.

being by no means subject to derangement from sudden gusts of wind from the roof in the manner noticed above.

All the light-houses in the district of the Scotch Commissioners are under the charge of at least two light-keepers, whose duties are to cleanse and prepare the apparatus for the night illumination, to mount guard singly after the light is exhibited, and to relieve each other at stated hours, fixed by the printed regulations and instructions under which they act. The rule is, that no keeper on watch shall, under any circumstances, leave the light-room until relieved by his comrade; and, for the purpose of cutting off all pretext for the neglect of this universal law, the dwelling-houses are built close to the light-tower, and means are provided for making signals directly from the light-room to the sleeping apartments below. The signals are communicated by air tubes (Plate XII.) which pass from the light-room to the sleeping apartments in the houses, and through which, by means of a small piston, or a puff of wind from the mouth, calls can be exchanged between the keepers. The man on guard in the light-room, at the end of the watch or on any sudden emergence, may thus summon his comrade from below, who, on being thus called, answers by a counter-blast, to show that the summons has been heard and will be obeyed. For the purpose of greater security, in such situations as the Bell Rock and the Skerryvore, four keepers are provided for one light-room; one being always ashore on leave with his family, and the other three being at the light-house; so that, in case of the illness of one light-keeper, an efficient establishment of two keepers for watching the light may remain. At all the land light-houses also, an agreement is made with some steady person residing in the neighbourhood, who is instructed in the management of the light and cleansing of the apparatus, and comes under an obligation to do duty in the light-room when called upon, in the event of the sickness or absence of one of the light-keepers. This person is called the *occasional keeper*, and receives pay only while actually employed at the light-house; but in order to keep him in the practice of the duty, he is required to serve in the light-room for a fortnight annually in the month of January. For the more minute details of the light-keepers' duty, I would refer the reader to the instructions already alluded to, which will be found at the end of this volume.

Each of the two light-keepers has a house for himself and family, both being under a common roof, but entering by separate doors, as shown in Plates XI. and XII., which exhibit the buildings for the new light-house at Adnarmurchan point, on the coast of Argyleshire. The principal keeper's house consists of six rooms, two of which are at the disposal of the visiting officers of the board, whose duty in inspecting the light-house or superintending repairs may call them to the station; and the assistant has four rooms, one of which is used as a barrack-room for the workmen, who, under the direction of the foreman of the light-room works, execute the annual repairs of the apparatus.

The early light-houses contained accommodation for the light-keepers in the tower itself; but the dust caused by the cleaning of those rooms in the tower was found to be very injurious to the delicate apparatus and machinery in the light-room. Unless, therefore, in situations such as the Eddystone, the Bell Rock, or the Skerryvore, where it is unavoidable, the dwellings of the light-keepers ought not to be placed in the light tower, but in an adjoining building.

Great care should be bestowed to produce the utmost cleanliness in every-

thing connected with a light-house, the optical apparatus of which is of such a nature as to suffer materially from the effect of dust in injuring its polish. For this purpose covered ash-pits are provided at all the dwelling-houses, in order that the dust of the fire-places may not be carried by the wind to the light-room; and, for similar reasons, iron floors are used for the light-rooms instead of stone, which is often liable to abrasion, and all the stone work near the lantern is regularly painted in oil.

If, in all that belongs to a light-house, the greatest cleanliness be desirable, it is in a still higher degree necessary in every part of the light-room apparatus, without which the optical instruments and the machinery will neither last long nor work well. Every part of the apparatus, whether lenses or reflectors, should be carefully freed from dust before being either washed or burnished; and without such a precaution, the cleansing process would only serve to scratch them. For burnishing the reflectors, prepared *rouge* (trioxide of iron) of the finest description, which should be in the state of an impalpable powder of a deep orange-red colour, is applied, by means of soft chamois skins, as occasion may require; but the great art of keeping reflectors clean consists in the daily, patient, and skilful application of manual labour in rubbing the surface of the instrument with a perfectly dry, soft and clean skin, without rouge. The form of the hollow paraboloid is such, that some practice is necessary in order to acquire a free movement of the hand in rubbing reflectors; and its attainment forms one of the principal lessons in the course of the preliminary instruction to which candidates for the situation of a light-keeper are subjected at the Bell Rock light-house. For cleansing the lenses and glass mirrors, spirit of wine is used. Having washed the surface of the instrument with a linen cloth steeped in spirit of wine, it is carefully dried with a soft and dry linen rubber, and finally rubbed with a fine chamois skin, free from any dust which would injure the polish of the glass, as well as from grease. It is sometimes necessary to use a little fine rouge with a chamois skin, for restoring any deficiency of polish which may occur from time to time; but in a well managed light-house this application will seldom, if ever, be required.

The machinery of all kinds, whether that of the mechanical lamp or the revolving apparatus, should also be kept scrupulously clean, and all the journals should be regularly and carefully oiled. * * *

There are now no fewer than twenty-six floating lights on the coast of England.

By the kindness of the Elder Brethren of the Corporation of Trinity House of Deptford Strond, I am enabled to give the following brief sketch of the nature and peculiarities of floating lights which was communicated to me by Mr. Herbert, the secretary of the corporation:

“The annual expense of maintaining a floating light, including the wages and victualling of the crew, who are eleven in number, is on an average £1,000; and the first cost of such a vessel, fitted complete with lantern and lighting apparatus, anchors, cables, &c., is nearly £5,000. The lanterns are octagonal in form, five feet six inches in diameter; and, where fixed lights are exhibited, they are fitted with eight Argand lamps, each in the focus of a parabolic reflector of twelve inches diameter; but, in the revolving lights, four lamps and reflectors only are fitted. The greatest depth of water in which any light-vessel belonging to the Corporation of Trinity House of Deptford Strond at present rides, is about forty fathoms, (which is at the station of the *Seven Stones* between the Scilly Islands and the coast of Cornwall.)

“ The corporation’s light-vessels are moored with chain-tables of $1\frac{1}{2}$ inch diameter, and a single mushroom anchor of 32 cwt., in which cases the chain-cables are 200 fathoms in length ; some of said vessels are moored to *span-ground* moorings, consisting of 100 fathoms of chain to each arm, and a mushroom anchor of similar weight at the end of each ; a riding cable of 150 fathoms being in such cases attached to the centre ring of the ground chain. The tonnage and general dimensions of the light-vessel are given on the drawing of the lines.”

Still lower in the scale of “ signs and marks of the sea,” are beacons and buoys, which are used to point out those dangers which, either owing to the difficulty and expense that would attend the placing of more efficient marks to serve by night as well as by day, are necessarily left without lights, or which, from the peculiarity of their position, in passages too intricate for navigation by night, are, in practice, considered to be sufficiently indicated by day-marks alone. Beacons, as being more permanent, are preferred to buoys ; but they are generally placed only on rocks or banks which are dry at some period of the tide. On rocks, in exposed situations, beacons are sometimes of squared masonry, secured by numerous joggles ; but, in situations difficult of access, and in which works of uncompleted masonry could not be safely left during the winter season, an open framework of cast-iron pipes, firmly trussed and braced, and secured to the rock with strong *louis-bats*, is preferred. The details of this framework are shown at Plate XIII. A stone beacon of about forty feet high may be erected for about £700, and an iron beacon for about £640. In less exposed places, where the bottom is rock, gravel or hard sand, a conical form of beacon, composed of cast-iron plates, united with flanges and screws, with rust-joints between them, and partially filled with concrete, is sometimes used. A beacon of that kind can be erected for about £400.

Lastly, buoys, which may be regarded as the least efficient kind of mark, and as bearing the same relation to a beacon that a floating light does to a light-house, are used to mark by day *dangers* which are always covered even at low water, and also to line out the fairways of channels. They are of three kinds, viz. : the *nun-buoy*, in the form of a parabolic spindle, generally truncated at one end, so as to carry a mast or frame of cage-work, and loaded at the other end, so as to float in a vertical position ; the *can-buoy*, which is a conoid floating on its side ; and, lastly, the *cask-buoy*, which is a short frustum of a spindle truncated at both ends, but almost exclusively used for carrying the warps of vessels riding at moorings. Those buoys are of various sizes and differ in cost. Mast-buoys, from ten to fifteen feet in length, cost from £23 15s. to £48 ; and those of the Ribble and the Tay, which are twenty-one and twenty-four feet long, cost respectively £105 and £79 ; the *can-buoys* are from five to eight feet long, and cost from £13 13s. to £20 5s. Smaller buoys are also used in narrow estuaries or rivers. Large buoys are often built on *kneed* frames resembling the timbers of vessels. The cask-buoy is generally six feet long, and costs £22 15s. All those buoys are formed of strong oaken barrel-staves, well hooped with iron rings, and shielded with soft timber ; and the nozzle-pieces at the small end of the *nun* and *can-buoys* are generally solid quoins of oak or iron, formed with a *raglet* or groove to receive the ends of the staves. Much skill on the part of the cooper is required in heating and moulding the staves to the required form ; and great care must be taken that they be of well-seasoned timber. Buoys are not caulked with oakum,

but with dry-flags, which are closely compressed between the edges of the staves and swell on being wet; and they are carefully proved by *steaming* them like barrels, to see if they be quite tight. Sheet iron is sometimes used in making buoys, and they are then sometimes protected with fenders of timber; but they have been found more troublesome for transport, and, for most situations, are considered less convenient than those of timber. An attempt has lately been made, under my direction, to construct buoys of *gutta percha*, stretched on a frame of timber; but I cannot at present speak confidently of the result.

In the beginning of 1845, I suggested the idea of rendering beacons and buoys useful during night, by coating them with some phosphorescent substance, or surmounting them with a globe of strong glass filled with such a preparation, whose combustion is very slow, and emits a dull whitish light and little heat. Some experiments were accordingly made; but no practically useful result has been obtained.

In laying down beacons or buoys, their position is fixed either by the intersection of two lines drawn through two leading objects on the shore, (the magnetic bearings of which are given for the sake of easy reference on the spot, in finding out the marks,) or by means of the angles contained between lines drawn to various objects on the shore, which meet at the beacon or buoy from which they are measured by means of a sextant. In the latter case, the angles are always measured around the whole horizon, thus affording a check by the difference of their sum from 360° . The magnetic bearing of one of those lines is afterwards carefully ascertained by means of the prismatic compass (if possible from one of the objects on shore, and if not, conversely from the beacon or buoy), so as to afford the means of translating the whole into magnetic bearings for the use of seamen. The buoys are moored by means of chains and iron sinkers, with a sufficient allowance in the length of the chain to permit them to *ride* easily. * * *

O—No. 2.

REPORT ON LIGHTS FOR LIGHT-HOUSES.

From the Journal of the Franklin Institute.

HALL OF THE FRANKLIN INSTITUTE,
Philadelphia, May 10, 1849.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, in compliance with the following resolution passed by the Franklin Institute at their meeting held April 19, 1849, viz: "*Resolved*, That the Committee on Science and the Arts be requested to examine and report to the next meeting of the Institute, their opinion of the relative value of the present catoptric system adopted in the United States, compared with the Fresnel dioptric and catadioptric system established in the light-houses in Europe and elsewhere, so far as the same can be obtained from documents in the possession of the Institute," report:

That they have examined the subject entrusted to them with the care and attention which its great importance demands. The immense

amount of property, and the many valuable lives dependent on the proper illumination of coasts and harbors, have attracted the attention of men of science, and nearly all civilized governments. The results have been witnessed in the very great improvements in the structure of light-houses, and in their reflecting and refracting apparatus, especially of the latter.

The committee have studied the voluminous documents containing not merely the opinions of a number of the most scientific men in Europe and America, but the actual practical results described in official statements of light-house boards, in every country where lights of high character have been established. They have examined much voluminous correspondence, and have endeavored to avail themselves of every attainable source of information relating to the subject. They have also examined the dioptric and catadioptric apparatus of Fresnel, as displayed in the four orders exhibited before the Franklin Institute.

The catoptric system adopted in the United States is a very imperfect imitation of the European method, which was in use long before its *alleged* invention in this Union. Paraboloidal reflectors, with lamps placed in their foci, were in use nearly seventy years since in France and Great Britain. The addition of a convex lens in front of the lamp, placed in the focal point of such a reflector, could only have been suggested by a person entirely ignorant of the elementary principles of optics.*

We need not, however, at present enter into the history of the light-house system of the United States. We are gratified to learn that a few improvements have been made by the introduction of better forms of reflectors, and in their adjuncts, as well as in their size, finish, and mountings, but these few cases are merely exceptions to the general rule; and it must be acknowledged that the catoptric system of this country is, in actual practice, far inferior to the catoptric system of Europe. (1) We do not deem the former to be of sufficient value to contrast with the dioptric and catadioptric system of Fresnel, which is rapidly superseding even the latter (the reflecting system) in its best condition. We therefore limit our comparison to the reflecting apparatus of Europe and the apparatus of Fresnel.

A paraboloidal reflector of the best description receives but two-thirds of the light emitted from the lamp; half of this only is reflected, equal to one-third of the whole, (2) and of this third a portion is intercepted by the intervention of a part of the lamp, diminishing the available light to less than one-third—perhaps to one-fourth; and of this one-fourth, a considerable portion is, from the divergence of the penumbral cone, too faint to produce much effect at great distances. In fixed lights many such reflectors are arranged in one or more circles or arcs; but even when very numerous, viz: from twenty to thirty, the light is very unequally distributed, and in some azimuths is invisible; when the reflectors are less numerous, viz: from ten to twenty, this defect is still more manifest. (3)

With the refracting and catadioptric apparatus of Fresnel for fixed lights, the whole circle is equally illuminated, especially when the latest improvements have been introduced, (4) and nine-tenths nearly of the light emitted from the lamp is rendered available; † (5) glass, as a refract-

* The small spherical reflectors are also defective in principle, but it is not necessary to discuss the defects of this antique apparatus.

† Subject, of course, to a *small* deduction in the passage through the glass.

ing material in this system, possessing the same advantage over reflectors as the refracting telescope possesses over the reflecting species. The consumption of oil to produce an equal light might readily be inferred to be much less, and practice has proved beyond a doubt that such is the fact. (6)

The superiority of the revolving and of the flashing lights of Fresnel over the revolving reflecting lights must also be conceded. (7) The superior brilliancy of these lights, the intense concentration of their rays, consequently their penetrating power, as well as their *economy in the consumption of oil*, being manifest to the committee, it remains to inquire whether their first cost or the expense of their management be greater.

In Europe, *for a light of equal intensity*, the first cost is not greater, but as in practice the Fresnel lights are *much more intense* than the reflecting lights, *the first cost* of the apparatus is, in a small ratio, greater than that of the latter, *when of the best description*, (8)—of course we do not allude to the imperfect apparatus in this country,—but their great economy in oil is more than a compensation for the small additional prime cost. (9) They do not require more persons to attend to them, although, in fact, more are required in Europe, for both reflecting and refracting lights, than in the reflecting lights of the United States, but this increase is entirely owing to the importance there justly attached to the maintenance of a steady constant light, which cannot be insured in either system when one keeper only is employed. (10)

The committee are strongly impressed with the great excellence of the Fresnel system,—a system which has already been established in nearly three hundred places (and every where with satisfaction) in Europe, where it is gradually superseding the old and imperfect catoptric lights, whilst in no instance has it been abandoned after it has been established.

The opinion of scientific men throughout the world is believed to be decidedly in favor of the Fresnel system of lights, where a large arc of a circle requires illumination. In the United States, this invention has been introduced only at one station. The committee earnestly hope that our whole coast, wherever it may be adapted to them, on both oceans and on the lakes, may speedily be provided with this brilliant, economical, and admirably devised gift of the science and art of the nineteenth century.

By order of the committee,

WILLIAM HAMILTON, *Actuary*.

Appendix containing the notes referred to in the report.

NOTE 1. Communication from Messrs. E. & G. W. Blunt, of New York; 25th Congress, 2d session; documents 258 and 738.

Report from I. W. P. Lewis, civil engineer, upon the condition of the light-houses, beacons, buoys, and navigation upon the coasts of Maine, New Hampshire, and Massachusetts; 27th Congress, 3d session; document 183, H. Rep.

Extracts from a report upon the dioptric light, addressed to the Secretary of the Treasury, by I. W. P. Lewis, civil engineer, April 23, 1845.

“One of the most remarkable defects in the fitting up of our light-houses is in the diminutive size of the reflectors, which, for the most part, are only fourteen inches in diameter; the burners are uniformly three-fourths

of an inch in diameter. Now these same burners would illuminate a reflector of twenty-five inches in diameter just as perfectly as they do the reflector of fourteen inches diameter, and the gain of light, without any increase in the consumption of oil, would be thus :

Taking the magnifying power of a 25-inch reflector at-----327 burners,
Then, by proportion, the 14-inch reflector has a magnifying
power of-----103 burners.

Loss of light by use of small reflector-----224 burners.

In other words, we lose two-thirds of the light generated in our burners, by using small reflectors instead of large ones. We may use any other figures to represent the relative power of the two sizes of reflectors above named, but the proportion will remain the same. In France, reflectors of thirty-six inches diameter were formerly in use, and the standard sizes adopted in Great Britain for the last thirty-five years has been twenty-five inches for revolving lights, and twenty-one inches for fixed lights."

"By the United States catalogue of 1842, the various sizes of reflectors then in use at 242 light-houses were—

Of 9 inches diameter at-----	21	stations.
14 " " -----	127	"
15 " " -----	46	"
16 " " -----	17	"
18 " " -----	2	"
21 " " -----	19	"
Size not stated, but supposed to be fourteen inches-----	19	"
		242

"In every fixed light, the number of lamps and reflectors should correspond to the extent of horizon to be lighted. Each parabolic reflector has an effective divergence of not more than 15 degrees in azimuth; consequently a light located on a rock in the sea, like Boon island or Mount Desert, should have 24 reflectors, because these lights are required to illuminate a navigable horizon of 360 degrees, and because $15 \times 24 = 360$. But Boon island has only 12 reflectors, or half the number it should have, and Mount Desert has only ten reflectors. In the first, each reflector is expected to cover a sector of 30 degrees in azimuth, while the latter must be supposed to cover 36 degrees of azimuth by each reflector, in order to render its light visible from all parts of the horizon. This extraordinary deficiency in the proper number of lamps and reflectors is common to all the fixed lights on our coast, and there is one case where there are but seven reflectors for the entire circle of the horizon, which implies an effective divergence of $51\frac{2}{3}$ degrees for each reflector. The 28 exterior fixed lights in the annexed catalogue are illuminated with 276 lamps. According to the sea horizon which each of these is *supposed* to illuminate, there should be 503 lamps, allowing the effective divergence of a reflector to be fifteen degrees. Mr. Alan Stevenson only allows 11 degrees of divergence, and states that, if more than this is permitted, the lights will be visibly weaker in the points intermediate between any two adjacent reflectors. At a distance of ten miles, many of our fixed lights are hardly visible from the cause above stated, and in hazy weather it would be physically impossible for any one to see either of the two lights above named, from a point inter-

mediate between the axes of any two reflectors, at even one-half that distance."

"It is evident, from the foregoing statement, that, in order to make our fixed lights as equally brilliant in all azimuths as they now appear only in particular directions, it will be necessary to double the number of lamps and reflectors, and consequently the consumption of oil. * * * In the dioptric system of fixed lights, we have the very reverse of all this. The economy for each order respectively is greatest when it is required to illuminate the entire horizon of 360 degrees; because, to increase its range of usefulness, we do not add lamps, but only lenses."

The following table shows the illuminating power of the combined effects of ten parabolic reflectors of 25 inches diameter, representing one face of a revolving light of three faces, or 30 lamps in all. This is compared with a lens light of the first order revolving, and having eight faces, each one being equal in illuminating power to ten reflectors of 25 inches diameter. The reflecting light illuminates only three points of the horizon in its rotations, and consumes 1440 gallons of oil per annum, while the lens light illuminates eight points of the horizon in its rotations, and consumes but 600 gallons of oil per annum."

The lenses make their revolutions in 21 minutes and 20 seconds, and the reflectors in eight minutes. The beam of light from each system, therefore, occupies equal times in passing the eye of the observer, the reflectors having 15 degrees of divergence, while the lenses have but six degrees of divergence. The illuminating power of each is expressed in Argand burners, and the table is quoted from the experiments of W. H. Barlow, Esq., C. E., who investigated the subject by command of the Sultan of Turkey.

Seconds of time.	Single reflector with Argand inch burner.	Ten reflectors with Argand inch burners.	French lens 4-wick burners.
1	0.0285	0.285	?
2	0.0617	0.617	?
3	0.1019	1.019	10.4
4	0.1501	1.501	10.4
5	0.2133	2.133	10.4
6	0.2937	2.937	10.4
7	0.4019	4.019	10.4
8	0.5555	5.555	10.4
9	0.7905	7.905	10.4
10	1.0000	10.000	10.4
11	1.0000	10.000	10.4
12	1.0000	10.000	10.4
13	1.0000	10.000	10.4
14	1.0000	10.000	10.4
15	1.0000	10.000	10.4
16	1.0000	10.000	10.4
17	0.7905	7.905	10.4
18	0.5555	5.555	?
19	0.4019	4.019	?
20	0.2937	2.937	Dark.
21	0.2133	2.133	do
22	0.1501	1.501	do
23	0.1019	1.019	do
24	0.0617	0.617	do
25	0.0285	0.285	do
26	Dark.	Dark.	do

These figures illustrate the peculiarities of the reflector and the lens. * The reflector does not attain the maximum of its power until the tenth second of time in its rotations, and retains this power only for seven seconds, while the lens reaches its maximum effect in the third second of time, and retains it for fifteen seconds. The gradual increase for each second of time in the illuminating power of the reflector, until it reaches its maximum, the short duration of its maximum, and rapid decrease to minimum power, prove the important fact that this instrument has not sufficient effective divergence to be used advantageously for fixed lights in comparison with dioptric lights, whose peculiar value consists in a perfectly equal distribution of light to all azimuths—an effect not attainable with reflectors.

“In the foregoing tables, the duration of the highest periods is as 14 to 6: that is to say, the number of degrees of the horizon illuminated with the brightest light, by the eight faces of a system of lenses, is to the brightest light by the three sides of a reflector frame as 14 to 6. Consequently we should require seven sides to our reflector frame, to be equal in this respect to the lenses; and as each side must have ten reflectors to be equal in power to one face of the lens system, we should require to consume the oil of seventy Argand lamps to produce the same effect with the present construction of our reflectors, as that which is obtained from lenses with the consumption of thirteen Argand lamps, viz:

70 lamps at 48 gallons per year is	-	-	-	3360
13 do. do. do.	-	-	-	624
Excess	-	-	-	<u>2736</u>

Extract from the reply of Captain W. H. Swift, Topographical Engineer, to the interrogatories addressed to him on the 14th April, 1842, by the commissioners appointed to investigate the affairs of the New York custom house; being his answers to the first six questions.

1. I am a captain in the corps of topographical engineers, and my present station is Springfield, Massachusetts.

2. I am somewhat familiar with the appearance of the lights in Long Island sound. I have been in the habit of passing and re-passing them several times during the year, for twenty years past. With those on other parts of the coast I am less familiar, but have seen many of them.

3. I have noticed the appearance of a number of the lights on the western coast of England, and the eastern coast of Ireland—for example, the Holyhead, Skerries, Tuskar, Mouth of Wyre, and others in the Irish sea. I have not noticed any of the lights upon the coast of France.

4. I have never *seen* upon our coast a light which approached, in a remote degree even, the brilliancy exhibited by the English lights, which I have referred to above. It is proper that, at the same time, I should state that I have not yet seen the lights at Navesink, fitted with the lenticular apparatus of Fresnel; nor have I seen the lights at Boston and Stonington, fitted with the English illuminating apparatus. I can perceive no reason why these three lights should not be equal in brilliancy to those of the same class in England and France.

5. The great difference in the appearance between our lights and those of England is ascribable, I conclude, entirely to the superior character of the illuminating apparatus adopted in England. In that country, reflectors of proper form and of great size (from twenty-one to twenty-eight inches in diameter) are in use; while with us, as I perceive by a statement of the Fifth Auditor, of December 1, 1839, the reflectors in our lights vary from nine to sixteen inches diameter, three lights only being furnished with reflectors of eighteen inches. Not only the size but the shape of the reflectors affects materially the quantity of light furnished by a given lamp, as may be readily supposed. I cannot state from personal knowledge whether sufficient attention has been given to the shape and reflecting surface of the reflectors; but, judging from information which I have received, and from the report of the naval officers appointed to examine the light-house in 1838, (document 24, H. R., December 13, 1838,) I should infer that, in this respect, this important matter had not received sufficient attention.

The French apparatus (Fresnel's) is again superior to the English. Both are immeasurably superior to our own, as all may perceive who will read the descriptions of the several systems adopted by each country.

6. The reply to question five furnishes an answer to the greater part of No. 6. The *principle* of the illuminating apparatus is claimed to be similar to that of the English, but the immense superiority of the lights of the latter, in point of brilliancy, would seem to disprove the statement. I repeat, that such of the English lights as I have seen far exceed in brilliancy those of our own coast, with the appearance of which I have stated myself to be familiar.

Letter from the Secretary of the Treasury of the United States, with reports and documents; 25th Congress, 3d session, H. R. Doc. 24.

Report of Mr. Davis; 6th Congress, 1st session, S. Doc. 474.

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Report of Professors Pierce and Lovering, of Harvard University, on Fresnel's dioptric apparatus for light-houses, February, 1846.

To the President of the Boston Marine Society, the undersigned respectfully submit the following report upon the sea-lights exhibited by I. W. P. Lewis, esq.

We have carefully examined these lights, and find them to be identical with Fresnel's catadioptric lights, which are well known to European navigators, and which, after repeated and earnest investigations by men of the highest scientific character, and by those practically familiar with the subject of light-houses, have been approved and adopted by the principal maritime powers of Europe, viz: France, Holland, England, Sweden, Denmark, Spain, Sardinia and Naples.

They have, from the time of their introduction, been gaining the favor of the world, and there are now two hundred light-houses furnished with them, and there is no complaint of their inadequacy to the wants of navigation. On the contrary, the universal testimony is that of unequivocal and decided approbation, and among the witnesses we find the names of two of the most accomplished officers of our own navy, Lieutenants Blake

and Gedney, and a distinguished officer of the topographical corps, Captain W. H. Swift.

Impressed with the deep importance of this subject to the welfare of commerce and the safety of the mariner, we have devoted much time to our own examination of the lights, and having no desire to arrive at one result rather than another, we have been subject to no bias in the investigation; our conclusions must therefore be regarded as those of an entirely independent authority, and it will be seen that they do not differ materially from those of the Bell Rock committee, appointed by the British board of commissioners of Northern light-houses to investigate these lights, and who, under the guidance of Sir David Brewster, devoted three years to this important examination. The executive member of this committee, and the one who arranged all the apparatus, was Robert Stevenson, esq., whose official prejudices (as chief engineer of the northern light-houses) were known to be strongly in favor of the old system of reflectors.

Our conclusions are also the same with those of Mr. Alan Stevenson, (who has succeeded his father as chief engineer,) and with those of Captain Drummond, the inventor of the Drummond light, and of Mr. Barlow, and of Fresnel himself.

The advantage of Fresnel lights over the reflectors is obvious and easy to be understood. It consists, primarily and simply, in catching those portions of light which are lost in the system of illumination by reflectors, either because such portions pass too high into the upper regions of the air, or because they pass too low, and strike the earth at a short distance from the light-house. The light which is thus caught is thrown into a direction sufficiently near the horizon to become useful to navigation. The gain over the reflector is precisely similar in character to that of the reflector over the unaided light, and the light of the refractor or lens bears about the same ratio to that of the reflector which that of the reflector bears to the unaided light. Thus, twenty-nine-thirtieths of an open light must be lost, and only one-thirtieth would be practically useful to navigation; but the addition of a reflector of the best model and finish reduces the loss to five-sixths of the whole amount of light, and renders one-sixth of the light practically useful. But the substitution of the dioptric apparatus reduces the amount of lost light to one-sixth of the whole amount of light, and renders five-sixths of the light available: in other words, the serviceable portion of the open light is about $3\frac{1}{3}$ per cent., that of the best reflector is seventeen per cent., and that of the dioptric apparatus is eighty-three per cent., of the whole amount of light generated. This enormous superiority of the dioptric apparatus is its characteristic feature, and constitutes the strong and unanswerable argument in its favor. The dioptric light, under all circumstances, whether exhibited as *fixed*, *revolving*, *flashing*, or *intermittent*, gives *five times* the amount of light of the reflector for the same consumption of oil. (See note, next page.)

A secondary consideration of no little practical importance, is the circumstance that the "*fixed*" dioptric light is much more perfect than the "*fixed*" light by reflectors, because its light is diffused *equally in every direction*. This is not the case with the reflector, for if ten reflectors, for instance, of the best model, are arranged upon a circular stand as a *fixed* light, each lamp illuminates only a small portion of the horizon in front of its reflector. Hence not more than one lamp (of the ten) can be seen in

any direction, and there are large intervals in which no lamp can be seen. The dark spaces are even larger in this case than the illuminated portions, so that only forty-two per cent. of the whole horizon is lighted, and less than twenty per cent. is lighted with the full power of a single lamp. The dioptric light, on the contrary, is seen in every direction with the same brilliancy. The only objection to the dioptric light arises from the dependence upon a single lamp, fed by a mechanical contrivance. Any injury to the valves might extinguish the lamp, and it would take about twenty minutes to re-light it. Experience seems, however, to have shown that this danger is more speculative than real, for there is no public complaint of any such occurrence, nor are we informed of its having happened. We are also of opinion that this danger might be avoided by the substitution of a large fountain lamp for the mechanical lamp.

Our attention has incidentally been drawn to the great inferiority of the reflectors generally used upon the American coast, by which the amount of available light is much less than one-half of that which would be given by a good reflector of suitable dimensions. The gain of the dioptric light over such a reflector cannot be less than in the ratio of ten to one. Hence it is that Mr. Lewis has been able to exhibit the accompanying schedule of our northern lights, in which he fairly proposes to furnish nearly three times the amount of light with only about one-third of the present consumption of oil. With about 8,800 gallons of oil, he gives nearly three times the amount of light actually furnished with 26,400 gallons, and as much light as, on the present wasteful system, would be derived from the consumption of 78,000 gallons of oil. In this proposition there is no mystery or deception, nor any reasonable room for doubt or distrust. The principles of this gain are admitted by all scientific men as incontestable, and admit of being tested by any man of good sense and decent acquirements.

We cannot close this report without expressing our deep sense of Mr. Lewis's thorough acquaintance with the whole subject of light-houses, both theoretically and practically—of his openness and candor in every point of the investigation, and his anxious desire to aid us in arriving at the truth.

Most respectfully, your obedient servants,

BENJAMIN PIERCE.
JOSEPH LOVERING.

HARVARD UNIVERSITY, *February 3, 1846.*

Note to Report.—This paper gives the result of our experiments, made for determining the comparative value of the catoptric and dioptric methods employed in light-houses.

These experiments were carefully conducted, without any bias, and with no desire but to find the truth.

The apparatus was furnished by Mr. I. W. P. Lewis, and arranged by him in working order, in the spacious hall over the new depot of the Boston and Maine railroad.

Our plan has been to compare the reflector with a Carcel flame placed at a given height, and then compare the Carcel flame with the dioptric light. When possible, the catoptric and dioptric lights have been brought into direct comparison as a kind of verification of the first result.

Although the number of our experiments has not been very great, we place considerable confidence in our conclusions, from the time and atten-

tion bestowed upon them, and a satisfactory correspondence between them and those which have been reached by men who have more fully investigated the subject in Great Britain.

Our examination extended to the following articles of the apparatus, viz :

1. An annular lens of the first order, with lamp of four wicks.
2. An annular lens of the second order, with lamp of three wicks.
3. A cylindric refractor of the third order, with lamp of two wicks.
4. The same varied by flashes.
5. A catadioptric series of the third order, small model, with an Argand lamp.
6. The same varied by flashes.
7. A catadioptric series of the fourth order, with Argand lamp.
8. The same varied by flashes.
9. A parabolic reflector of silver plate, 21 inches in diameter, and 4 inches focal axis, lighted with an American light-house lamp, with three-quarter inch burner.

Our results are as follows :

1. The annular lens of the first order is equal to the combined effect of nineteen such reflectors as are specified in No. 9 of the above enumeration. Its lamp consumes as much oil as nineteen of the Argand burners of three-quarter inch diameter, which are used in American reflectors.
2. The annular lens of the second order is equal to twelve of these reflectors. Its lamp consumes as much oil as thirteen of the above three-quarter inch Argands, which are used in American reflectors.
3. The cylindric refractor of the third order, used as a *fixed* light, spreads a uniform light in every direction equal to fifty-seven per cent. of the maximum effect of the above reflector in its best direction. Its lamp burns as much oil as six of the above three-quarter inch Argand burners.
4. This cylindric refractor is varied by flashes, so as to send a flash ten per cent. more powerful than the maximum flash from one of the above reflectors.
5. The catadioptric series of the third order, (small size,) shown as a *fixed* light, spreads a uniform light in all directions equal to twenty-five per cent. of the maximum effect of the above reflector. Its lamp burns as much oil as $2\frac{5}{8}$ of the above three-quarter inch Argands.
6. This catadioptric series, varied by flashes, gives a flash three per cent. stronger than the brightest light from one of the above reflectors.
7. The catadioptric series of the fourth order, shown as a *fixed* light, spreads a uniform light in all directions equal to twelve per cent. of the maximum light which goes in the best direction from one of the above reflectors. Its lamp burns as much oil as $1\frac{3}{5}$ of the above three-quarter inch Argands.
8. This catadioptric series, varied by flashes, gives a flash seventy-eight per cent. as great as the maximum light that goes from one of the above reflectors.
9. The above-named 21-inch reflector projects a beam of light equal, in its best direction, to one hundred and ninety Argand burners of one inch diameter, with a flame $1\frac{1}{2}$ inch high. This maximum power is confined to about three and a half degrees on each side of the axis. Its power is reduced, at the distance of seven and a half degrees from the axis, to twelve such Argand burners; accordingly the valuable light from such a

reflector is confined to a range of about five degrees on each side of the axis. The mean effect of such a reflector, if averaged over a range of seven and a half degrees each side of the axis, is equal to one hundred and twenty of such Argand burners.

BENJAMIN PIERCE.
JOSEPH LOVERING.

NOTE 4. Refer to the same authorities.

NOTE 5. Report to the British Parliament, 1845, before cited.

See the appendix to the report of 1845, to the British Parliament, before cited. Memorandum by Mr. Alan Stevenson. Also, the notes on the illumination of light-houses, by the same writer, before cited, containing the results of experiments on the loss of light by reflection, and the transmission of light by the dioptric lenses and the catadioptric ring.

NOTES 6, 7, 8, 9, and 10. See the Senate document No. 488, 28th Congress, first session. Also, the letter of Leonor Fresnel, before cited. Also, the *Annuaire*, by Arago, before cited. Also, the report to the British Parliament, before cited. Also, report of Mr. I. W. P. Lewis, before cited. Also, report of the committee of the Royal Society of Edinburgh, before cited. Also, art. 13, vol. 127, p. 211, of the philosophical transactions of the Royal Society of London, for 1837, "on the adaptation of the different modes of illuminating light-houses," &c. In this paper, the relative effect of varying the size of the reflectors and lamps is discussed.

See also, *Edinburgh review*, vol. lvii., for 1833, art. 8, page 169, "on the construction of Polyzonal lenses and mirrors of great magnitude, for light-houses," &c., by David Brewster, LL. D., F. R. S. Also, *Edinburgh Philosophical Journal*, vol. viii. p. 160, for 1823; "Account of a new system of illumination for light-houses," by the same author; *Edinburgh*, 1827. Also, *Edinburgh Review*, vol. lxi. 1835, art. 13, 221, by the same. Also, the communication from Messrs. E. & G. W. Blunt, of New York, before cited. Doc. 258 and 738, 25th Congress, second session. To the zeal and intelligence of these gentlemen, the United States are indebted for the introduction of the Fresnel system at the Navesink station, near New York.

A lenticular fixed light is to be erected on the Brandywine Shoals, in Delaware bay, on a screw pile light-house. Another, a fixed and flashing light, with the *latest improvements*, is to be erected on an iron light-house on Carysfort reef, Florida, (on piles of iron inserted into the rock of the reef.) Another has (the committee have been informed) been ordered, of a singular pattern, which may be described hereafter. The lenticular light, (so called,) on the Battery of New York, does not pertain to the Fresnel system, and needs, at present, no further notice.

The documents relating to light-houses, published by Congress, before cited, may be consulted for such defence as has been essayed of the system and practice pursued in the United States.

The committee might cite many additional authorities, but their space is limited. They have, moreover, confined their references, to the sources of information which are readily accessible to the citizens of this country.

O—No. 3.

Extract from the Journal of the Franklin Institute.

AN ACCOUNT OF THE CONSTRUCTION OF THE NEW LIGHT-HOUSE AT THE PORT OF HAVANA, CUBA.

By Senor Don Jose Benites, Colonel of Royal Engineers.

[Translated from the Spanish for the Journal of the Franklin Institute.]

The improvement of the light at the Moro Castle, which serves as a guide to vessels entering the port of Havana, in such manner as to correspond not only with the importance of its commerce, but also with the perfection to which the construction of this kind of apparatus has now attained, having been determined upon by the royal junta of protection, the department of the marine was naturally consulted with regard to the most eligible situation and the proper altitude of the new light.

That illustrious body was of opinion that a light placed at the same entrance to the port as the former one, would be preferable to a light elsewhere, although it might be situated on a more elevated point of the coast, owing to the particular configuration of which, it might be seen from further to the windward. With regard to the height, it was judged sufficient to give an additional elevation of twenty-five feet to the old tower, because the light, being thus placed at one hundred and forty-two feet* above the level of the sea, would overlook the point called Del Pajonal, which bears about N. 71° E., and might, therefore, be readily distinguished and recognized by vessels approaching the port from that direction, within not less than eight nor more than fifteen miles of the coast, and affording still greater advantages to those standing in more from the northward. And, moreover, that with the proposed elevation, this light-house would be one of the highest which are known.

In accordance with this report, the junta determined, on the 22d of April, 1840, to proceed with the execution of the work, and its President, the most excellent Captain General, directed that the corps of engineers should make the proper examination, in order to ascertain the practicability of giving to the old tower the desired additional elevation. By a report of the commandant, June 2, 1840, it was declared practicable to add the proposed twenty-five feet to the height of the tower, provided the work were carefully done, and with materials of the best kind.

In this state the project rested until the 16th of October, 1843, when the junta, through its president, asked that the funds necessary for the work should be remitted, inasmuch as it would also be necessary, in addition to the projected increase in the height of the tower, to order from Paris a lenticular lantern of the most improved kind, by Fresnel, to be placed therein. The requisite funds having been provided, it was resolved, on the 7th of April, 1844, to proceed with the work, but with the indispensable condition that the light should not be interrupted for a single night. Accordingly, the construction of a small temporary tower was commenced on the 22d of May, for the purpose of sustaining the light while the height of the old tower was being increased by additional mason-work.

* The Spanish foot here used is equal to 11.1 inches, and the *vara*, or yard, is 33.3 inches.

The great height of the platform upon which the temporary tower was constructed, rendered it unnecessary to give it an elevation of more than seven yard, in order to maintain the light at the same height as that at which it was placed in the old tower. Its immediate proximity to this, and the removal of the light to the temporary tower in a single day, rendered it unnecessary to give that notice in the public papers which would otherwise have been requisite in order to avoid dangerous consequences to vessels. On the 23d of July, 1844, the temporary light-house was first put into use; its cost, including the lantern, amounting to the sum of \$1,800. Its strength, and the judicious principles upon which it was constructed, were fully proved in the terrible hurricane of the 5th of October last; during which, though exposed, without the least protection from other buildings, to the force of the wind and the beating of the waves, it remained firm, and without other injury than a total destruction of the glass in the lantern.

The next step was the taking down of the lantern from the old tower, and to proceed with other preparations for increasing its height, when, on the 14th of August, 1844, notice was received by the board of engineers, from his excellency, the Captain General, that, by a resolution of the junta, adopted in virtue of a report from their commissioners, it was determined to suspend the work, and inquire whether it would not be more expedient, provided the funds were sufficient, to construct a tower upon a new plan, which should combine all the beauty, convenience, and facility which would be required for the proper management of an apparatus so complicated as that of Fresnel; advantages which could not be afforded by the old tower, on account of its limited dimensions, and its total want of accommodations for the persons entrusted with the care of the light during the night, as well as its narrow and inconvenient stairway. The board of engineers, as was to be expected, reported in favor of the new project, and at the same time submitted a plan and an estimate for the new tower. Both of these were approved by the junta at its session on the 16th of August, and the work was ordered to be carried into effect. On the following day, the demolition of the old tower was commenced, and, at the same time, the excavation of a foundation for the new one was begun, in order that the old materials might be used in it.

Situation of the new tower.—Of the rock upon which the Moro castle is built, that point which extends furthest towards the N. W., and on which the old tower stood, is divided from the rest by a cleft or fissure, and is also undermined by a large cavern, washed out by the continual beating of the waves. In order to avoid these defects, which might, in time, endanger the stability of the new edifice, and also because the space afforded for the ground plan was not sufficient, a place was chosen eighty-four feet further back than the position occupied by the old tower, and on the broadest part of the glacis of the Morilla—a position combining all the advantages of the former one, besides leaving free the extreme point of the Morillo—for the erection of a battery of three Paixhan guns, of large calibre, in such a very advantageous position. Care was also taken to leave sufficient space about the new tower for the free use and management of the cannon which defend the entrance to the port, as well as of those on the opposite side.

Description of the tower.—It is composed of two parts; the first representing a column seventy-nine feet high, twenty-five feet in diameter at the base, and twenty at the top. The cornice of this serves as the floor of a

corridor with a circular parapet, enclosed by a grated railing of copper, which surrounds the upper, or second part, upon which the lantern is supported. The first or lower part is constructed of hewn stone, the wall being seven feet thick at the base, vertical in the interior, and sloping on the outside, thirty inches in the whole height. The interior space of eleven feet in diameter serves for a circular staircase, the steps of which are four feet long, seven and a half inches high, nineteen inches broad at the wide end, and six at the other, or immediately at the spindle or central column of three feet in diameter, which extends up through the whole height. The stairway begins inside, at thirty-eight inches in the clear from the door, in order to leave an open landing-place; the steps being covered with slabs of marble one and a half inch in thickness, with a moulding which extends an inch beyond the step. The doorway in the lower part of the tower, which gives entrance to the stairway, is four feet wide and eight feet high, with pilasters at the sides, and its cornice and frontispiece in the form of a circular arch. Over the door is a block of marble containing an inscription in Spanish of the following purport:

In the year 1844:

Isabella the Second reigning;

The Junta of Protection under the Presidency of
the Captain General of the Island, Don Leopold O'Donnell;

This work was executed under the direction of
the Corps of Engineers of the Army.

The stairway is lighted and ventilated by three sets of windows, placed equi-distant from one another throughout the whole height. They are four feet high and two feet wide, and in six of them the lower part of the niche, or recess in the wall which forms the window, is level with the steps, and serves as a landing, or resting-place. Below the stairway, and at the level of the lower floor of the tower, is a spacious room, enclosed by a wooden railing, which is used as a place of deposit for oil and the more heavy and bulky articles used about the light-house.

At the height of sixty-three feet nine inches, the stairway which has been described terminates in an apartment called the attendant's room, twelve feet in diameter and twelve and a half in height, covered by an arch two feet in the crown. This chamber, lined with marble, is intended for the two persons who have charge of the light during the night. It is furnished with windows, and the requisite conveniences for containing a supply of lamps, funnels, wicks, oil, &c., &c., having a staircase of mahogany, with a balustrade attached to the wall. The breadth of this stairway is twenty-four inches; the steps are a foot high and eight inches broad in the middle; it leads, through an opening left in the arch, to the platform, or upper part of the lower edifice.

Upon this platform is erected a second structure, consisting of a circular wall of hewn stone, two and a half feet thick, eight feet high, and eleven feet seven inches in its interior diameter. The latter dimensions are determined by the base and diameter of the lantern, which, as has been before said, rests upon it. In this second part of the tower there is a door six feet high by twenty-seven inches wide, to admit of egress to the platform, or corridor, above the cornice. In the floor of the apartment within the upper edifice, which is called the lantern-room, and which is also lined with marble, there are two apertures; one in the centre, which is circular and twelve inches in diameter, into which is introduced the foot or support of

the apparatus; the other is a foot and a half long by two inches wide, for the passage of the cord to which the moving weight is suspended. This weight is raised by means of a pulley placed in the arched ceiling of the attendants' room, and is enclosed in a case thirteen inches square and twelve yards long, formed in the thickness of the wall of the lower part of the tower.

The total height of the tower is, therefore, eighty-seven feet; which, added to the elevation of its base above the level of the sea, sixty-five and a half feet, and to the height of the light within the lantern, five and a half feet, will make the total elevation of the light one hundred and fifty-eight feet, the horizontal tangent of which is thirteen and a half marine miles. This exceeds, by sixteen feet, the height desired in the report of the marine department, and the light is consequently visible about a mile further than the distance required by them.

Description of the apparatus for lighting.—In order to give a clear and connected idea of this, we shall omit a detailed account of the numerous parts of which the various portions of this complicated machinery consist; and shall proceed to describe only such of them as will serve to make the mechanism understood, even by those who are not entirely familiar with the mechanical and optical principles upon which it is constructed.

The new apparatus for lighting consists of four distinct parts, as follow:

1. The mechanical lamp.
2. The system of prismatic lenses and reflectors placed around the light.
3. The machine which gives a uniform rotary movement to the prismatic lenses.
4. The glass lantern which covers the whole, without obscuring the light.

The mechanical lamp.—This lamp, placed in the centre of the lenses and reflectors, is supported by a hollow pillar of bronze, seven feet two inches high, having, below, a receptacle for the oil, and a set of pumps for raising it. These pumps are worked by machinery similar to that of a clock, the moving weight being contained within the pillar, and are capable of raising four times the quantity of oil which the burners require; from which it follows not only that the flame is maintained with all possible brilliancy, but also that the superfluous oil which flows over the exterior surface of the tubes, and falls back into the cistern, cools the points of the tubes, which might otherwise be fused by the intensity of the heat. In order to increase the watchfulness of those who have the care of the light, it is furnished with alarm bells. The escapement of this machinery is connected with one end of a lever, and at the other is suspended a vase with a small hole in the bottom. This vessel is so placed as to receive the superfluous oil from the burners, and while full, it sustains the counterpoise; but as soon as it begins to vary on account of a deficiency of oil, the lever loosens the movement of the alarm apparatus, which gives notice of the irregularity. A first class light has three lamps, so that if one of them shall be out of order, there are still two fit for use in good condition, and the light is constantly maintained. The Havana light has four.

The prismatic lenses and reflecting mirrors.—The lenses and reflectors, the object of which is to concentrate the rays of light which proceed from the burners of the lamp, in order to give them a horizontal direction, are placed in a metallic frame conveniently arranged, and which, as well as the lamp, rests upon the capital of the bronze column. One part of this

frame, which contains the reflectors, is stationary; while the other, containing the prismatic lenses, revolves around the lamp with a uniform motion. This revolution of the lenses causes eclipses of the light, according to the different positions which they successively occupy around the burner, producing a more intense and lively brilliancy in the direction towards which the focus of each lens happens to be directed, continuing thirty seconds before it is replaced by the next; though, on account of the stationary portion of the apparatus which contains the reflectors, there is always afforded, in all directions, a less brilliant light, but one which is still sufficient to enable the light-house to be kept in sight.

The machinery which gives motion to the prismatic lenses.—The mechanism of this is like that of a clock, and is placed at the side of the bronze pillar which supports the lamp. A pinion-wheel, gearing into another connected with the movable portion of the apparatus, puts it in motion by the action of a weight suspended to a cord passing through the floor of the room which contains the machinery, and descending below into a case made in the wall of the tower.

The lantern.—The glass lantern which encloses the light rests upon the circular wall built above the cornice of the tower, and has the figure of a prism of sixteen sides. It is covered by a cupola of copper, with a chimney in its top to carry off the gases proceeding from the combustion; the whole being surmounted by a weathercock.

By the foregoing description, it will be perceived that this light-house, when illuminated, presents constantly a steady light, uniformly alternating, every six seconds, with brilliant flashes, by which it may be distinguished from any other light.

The intensity of the steady light is equal to that given by five hundred and fifty burners like those of the ordinary Carcel lamp, which consume three and a quarter ounces of oil per hour, and it may be easily seen at a distance of six or seven marine leagues. The brightness of the flashes is nearly four times as great as that of the steady light, and equal to that given by two thousand of the above mentioned Carcel burners.

Data for determining the proper thickness for the wall of the tower.—The most interesting and nice question which first presents itself, in considering the construction of a very high tower, is to determine the thickness which its walls ought to have in order to insure the necessary stability, and to resist successfully the forces which have a tendency to destroy it. This is a general principle in all kinds of edifices; but in high towers, the base of which bears a small proportion to their height, it is necessary to consider another element of destruction more powerful and active than the force of gravitation, namely, the violence of the wind in those great hurricanes which are so frequent on seacoasts, particularly among the Antilles.

In the calculation of this force, as in all physico-mathematical questions, the data are, for the most part, derived from experiments, of the accuracy of which we cannot be precisely certain, but which have been found sufficiently worthy of confidence when applied to similar structures which have for many years resisted every kind of force; and in this case there is nothing more logical or natural, than to take the result of these calculations as established data of comparison with reference to our own case.

The data upon which we should reckon in calculations of this kind, founded upon numerous experiments, are as follows: First, the pressure

upon a superficial metre, when the wind has a velocity of fifty metres per second, which is that of the greatest hurricanes, is equal to the weight of two hundred and seventy-five kilogrammes, or about three hundred and eighty-six pounds to the square yard; second, the action of the wind upon a vertical cylinder is reduced to two-thirds of the force which it exerts upon a central vertical section of the same cylinder.

To apply these rules to the stability of a tower composed of a single stone in the form of a right prism with a square base, we should multiply the superficial area of one of its sides by three hundred and eighty-six pounds; and this product being multiplied by half the height of the prism, will give the momentum of the wind's force. In order to determine the momentum of resistance, the total weight of the tower should be multiplied by half the width of its base. Dividing this product by the first obtained momentum of the wind, we have the expression of the *absolute stability* of the edifice with regard to the action of hurricanes.

Towers are composed of numerous courses of cut stone, the adhesion of which affects the stability in proportion to the decrease in the size of the blocks of stone used. If we suppose this adhesion to be nothing in a wall composed of courses of stretchers and ties, the fracture caused by the force of the wind will not be horizontal; but (as in retaining walls) according to an oblique section, the inclination of which is determined by the maximum of relation between the force of the wind and the momentum of weight of the solid above the section. But it should be observed that in most high towers, the adhesion of the cement and the arrangement of the materials is such that the section of rupture is less inclined than in ordinary containing walls, and if, in addition to this, we also consider that the results which we seek are of comparison between our tower and those whose stability has been already tested by having for a long time resisted, without injury, every kind of force; the supposition that the section of fracture would be horizontal should have no sensible influence.

The determination of the section of most easy fracture offers a problem of minimums, the direct solution of which, in general, requires very tedious calculations; but fortunately the position of that section is apparent, in most cases, at the first glance of the eye, or may readily be determined by a few trials.

In case the tower should have the form of a truncated cone, like that of which we are treating, if it should ever yield to the force of the wind, it would be twisted off above the offset of its base, in the direction opposite to that from which it receives the force, and its being broken above the offset would be because the arm of the lever of resistance, instead of being equal to the radius of the section of rupture, is somewhat less.

These principles being established, it is known that, in order to give great stability to a circular wall in ordinary structures, it is sufficient to make the thickness a twelfth part of the height; consequently, having to raise our tower to a height of eighty feet, a thickness of seven feet was enough for the wall; but as the tower is not an insulated wall, but has within it, a circular stairway which binds and fastens together all its parts, and, moreover, as the consideration of a convenient situation for the illuminating apparatus required that the upper part of the tower should be only twenty feet in diameter, we were able to start with seven feet at the base, and to diminish gradually to four and a half at the top, with the advantage

of an exterior slope of two and a half feet in the whole height, which also adds to its strength.

Having established these data, it now remains to examine whether, with these dimensions, the tower possesses as much, or greater, strength than others similar to it, which have been built many years, and have resisted, without the least damage, the force of the greatest storms, and I say it ought to be stronger: 1st, Because the terms of the comparison which we seek are derived from towers built in Europe, where hurricanes are neither so frequent nor of such long duration as in the Antilles; and, 2d, Because the tower which we have constructed, from its peculiar situation, has to sustain not only the force of the wind but the shock of the waves, although this is somewhat diminished by the towers being placed twenty-two yards above the level of the sea.

For comparison, we will take the signal tower erected in 1715, at the port of L'Orient, the form of which is similar, on the whole, to that constructed at the Moro, and which has withstood until the present time, without injury, all the force of the storms.

Stability of the tower at L'Orient.—The result of a calculation with regard to this tower shows that the relation of the resistance to the pressure is 7.4; that is to say, the resistance is 7.4 times greater than the pressure. Let us now see what result will be obtained by an analogous calculation with regard to the tower at the Moro.

Calculation of the stability of the tower at the Moro.—The contents of the truncated cone which constitutes the lower part, is 31,174 cubic feet. The interior cylinder, which contains the staircase, is 11 feet in diameter and $34\frac{1}{2}$ in circumference; the area of its base, 95 square feet; and its contents $95 \times 78 = 7,410$ cubic feet. Taking this from the total solid contents, there remain 23,764 cubic feet for the solid contents of the circular wall of the lower part of the tower. The cylindrical column in the centre of the circular stairway contains 450 cubic feet, and the stairway itself 306; so that the total solidity of the masonry in the lower body of the tower is 24,520 cubic feet, or 908 cubic yards. Adding to this three cubic yards for the projection of the cornice, and subtracting thirty-six yards for the apertures left for doors and windows, there remain 875 cubic yards of masonry. As the attendants' room, in the lower section of the tower, is a foot larger in diameter than the interior space occupied by the stairway, it follows that the amount of masonry, which on this account has been rather over-estimated, will be made up by the arched ceiling of this room, which has not been taken into the account.

The solid contents of the circular wall which forms the upper section of the tower, upon which the lantern is placed, is twenty-seven cubic yards, deducting the opening for the door; so that the whole amount of solid masonry is 902 cubic yards.

A cubic yard of the masonry used in this tower weighs eighty-five arrobas, (twenty-five pounds each,) and the arm of the lever of resistance being four yards, (a little less than the radius of the base,) it follows that the power of the resistance will be $902 \times 4 \times 85 = 306,680$.

A central perpendicular section of the lower portion of the tower contains 195 square yards; of the upper portion, 13; and of the lantern, 26; presenting a total sectional superficies of 234 square yards. The centre of gravity of these three superficies is found at thirteen yards from the base of

of the tower; consequently the momentum of pressure from the wind is $\frac{2}{3} 386 \times 234 \times 13 = 31,504$ arrobas, and the ratio of the resistance to the pressure $= \frac{306,680}{31,504} = 9.7$.

By this result it will be seen that the tower at the Moro has a stability equal to nearly one and a half times that of the tower at L'Orient, which was taken for comparison, and consequently that its dimensions are sufficient, although indispensable for the reasons already mentioned, to warrant the undertaking of its construction with entire confidence.

Details of the construction: Foundation.—As the tower is twenty-five feet in diameter at its base, a circle $28\frac{1}{2}$ feet in diameter was traced around the centre of the area to be occupied by it; so that the excavation for the foundation being larger than the body of the tower, a berm or offset of twenty-one inches would be left by the extension of the foundation wall beyond that of the tower itself. The excavation was carried through the surface soil down to the rock which underlies the glacis of the Morillo, which was reached and laid bare at an average depth of fifteen feet.

The rock presented an irregular surface, in consequence of which, together with its extreme hardness, the operation of cutting it down to a level would have been very expensive. It was therefore deemed preferable to construct the foundation by steps, (*en escalones*), using blocks of stone of the best kind, disposed in circular horizontal layers, (*formando anillos en capas horizontales*), properly placed, and the joints filled with a mixture of lime and sand; taking care, as in all masonry of hewn stone, that the joints of each layer should be covered by the course immediately above it.

The foundation is nine and a half yards in diameter by five in depth, and consequently contains three hundred and fifty-five cubic yards of masonry. The cost of its excavation and refilling was \$1,554, being \$4.375 per cubic yard. In the calculation of the original estimate it was assumed that the foundation would be only three yards in depth; consequently containing two hundred and thirteen cubic yards, of which the cost, estimated at \$7.50 per yard for the masonry, including the excavation, amounted to \$1597.50, being an excess of \$43.50.

In calculating this estimate of \$7.50 per cubic yard of masonry, it was proposed to use all the materials of the old tower; but as this would not be sufficient, it was supposed that the stone still to be provided would have to be purchased and transported from the opposite shore. The great reduction which was made in the cost per cubic yard of this work, from that originally estimated, was owing to the following causes: *First*, Instead of buying from individuals the stones which were required, those were procured which remained unused from the erection of the fortifications at that place, and which had been taken from quarries opened for that purpose; on which account they were obtained at a much lower price, while, at the same time, the expensive transportation in vessels was avoided. *Second*, Because it was not necessary to purchase sand for making the cement, having used that which was found in the fosses of the fortifications.

The digging of the foundation was commenced on the 17th of August, 1844, and by the 24th of September it was completed and leveled off to nine inches below the glacis of the castle; being then in order for receiving the first layer of stone for the tower. During the same time the old

tower was completely taken down, its materials, as has been already said, being used for the new foundation.

The lower part of the tower.—Upon the level top of the basement, or foundation, the first layer of stone forms a solid floor over the whole, twenty-five feet in diameter; its outer border being vertical and forming a projection or socle of nine inches around the tower, as well as a step of the same height, for entrance into it. The building is then continued to the requisite elevation by successive courses of eighteen inches in height. In order to give an exterior slope to the wall, and consequently to diminish its thickness in due proportion, the width of the blocks in the interior courses was gradually contracted, while those on the exterior were of the same breadth, so that the vertical joints might recede gradually towards the interior, and the masonry be well united together; thus avoiding the defect which would result from an equal diminution in the breadth of the blocks used in both the inner and outer faces of the wall, in which case, the vertical joints of each course would continue to be one above another, thus forming two distinct walls, without further connexion than that of the extending ties.

The circular stairway is composed of entire blocks of stone, which are inserted six inches into the wall, each of them forming two steps, together with the corresponding part of the central column, or nave, of the staircase. It was carried up at the same time with the wall of the tower, in order to insure the proper connexion and binding together of the work, and also served for use during the construction of the building; the order of proceeding being first to set the block of stone which formed two steps, and then to lay the corresponding course on the wall, and so on successively. The nave, or central part of the stairway, is cylindrical throughout its whole height, except at the top, where it increases in diameter, with a view of gaining a certain space on the floor of the attendants' room. In order to give this proper form to the central column, its diameter was gradually enlarged, beginning at the seventeenth step from the top, and so continuing to the last; so that the stairway is only twenty-seven inches wide in the last six feet of its flight.

The upper part of the tower.—This is a simple circular wall of cut-stone, composed of blocks in alternate order, and presenting nothing worthy of special notice.

Arch of the attendants' room.—This arch is in the form of a simple dome, and presents nothing remarkable in its construction. The thickness of the wall which supports it is that which is strictly necessary for the equilibrium, since the excess in the weight of its masonry, from the spring of the arch to the key, and that of the upper part of the tower, which also contributes to its stability, are more than sufficient to compensate for the weight of the apparatus for illumination, which rests upon the summit of the arch. But notwithstanding this, as the three openings in it somewhat diminish its strength, the precaution was taken, in order to avoid the least displacement, to fasten all the arch stones of the second and third courses, together with those of the first, with iron clamps, one and a half inch thick by three inches wide, let into the arch stones and fastened to each of them by a bolt, which passes through two-thirds of their thickness, well secured with lead.

Materials.—The stone used in the construction of the tower was taken

from the quarries known here by the name of *playa de chivos*, immediately at the point where the tower stands, and preferable to the stone found at any other place in the vicinity, because, although not of the hardest quality, they are still sufficiently so, and of a more equal and homogeneous texture than the others. Great care was also taken to use blocks of the most durable kind in the exterior surface of the wall, and for the steps of the stairway.

The lime and sand employed were both of excellent quality; the former made of a very hard and clean stone, and the latter containing no saline matter. The mortar was made with great care, composed of two-fifths of lime and three-fifths of sand, mixed with fresh water and well stirred, so as perfectly to incorporate the ingredients.

The doors, windows, interior balustrades, and hand rails of the staircase are of mahogany.

After the completion of the edifice, in order to preserve it from the effects of moisture and of nitrous salts, inasmuch as the stone, as already stated, is not of the hardest kind, it was covered, both on the interior and exterior surface, with a very thin and well laid coat of painted stucco.

The cost of the structure, when completed, was very nearly that calculated in the original estimate.

[Extract from Journal of the Franklin Institute.]

Improvements in fixed and revolving lights, being a new diacatoptric instrument for increasing the intensity of the light. By THOMAS STEVENSON, Esq., F.R.S.E., C.E.

The author stated that this instrument is composed of three parts—a paraboloidal mirror, having the conoidal portion behind the parameter cut off, and its place supplied by a hemispherical reflector, whose centre thus coincides with the focus of the paraboloid, while in front of the flame is placed an annular lens subtending at the focus of the paraboloid, the same angle as that which is subtended at that point by the greatest double ordinate of the reflector, and having its principal focus coincident with that of the paraboloid. This instrument should theoretically produce the most intense light yet derived from any given flame, as it encloses and parallelizes each ray of the whole sphere of light, so that none are lost by divergence between the lips of the reflector, where, in the present arrangement, not very much short of one-half of the light is lost.

In this instrument, the hemispherical reflector throws the light which it receives, viz., the posterior half of the sphere of light, through the focus of the paraboloid, and while the outer ring of this light is received by the paraboloid, and parallelized by it, the central cone is received by the annular lens, and is also parallelized. The outer ring of the anterior half of the sphere of light is received directly by the paraboloid, and is parallelized by it; while the central cone of rays, which, in the present arrangement is lost by natural divergence, is received by the annular lens, and is parallelized by it. Thus the whole sphere of light is economized. This combination may also be applied *mutatis mutandis* to the illumination of half of the horizon of a fixed light, by means of a single light; the only difference

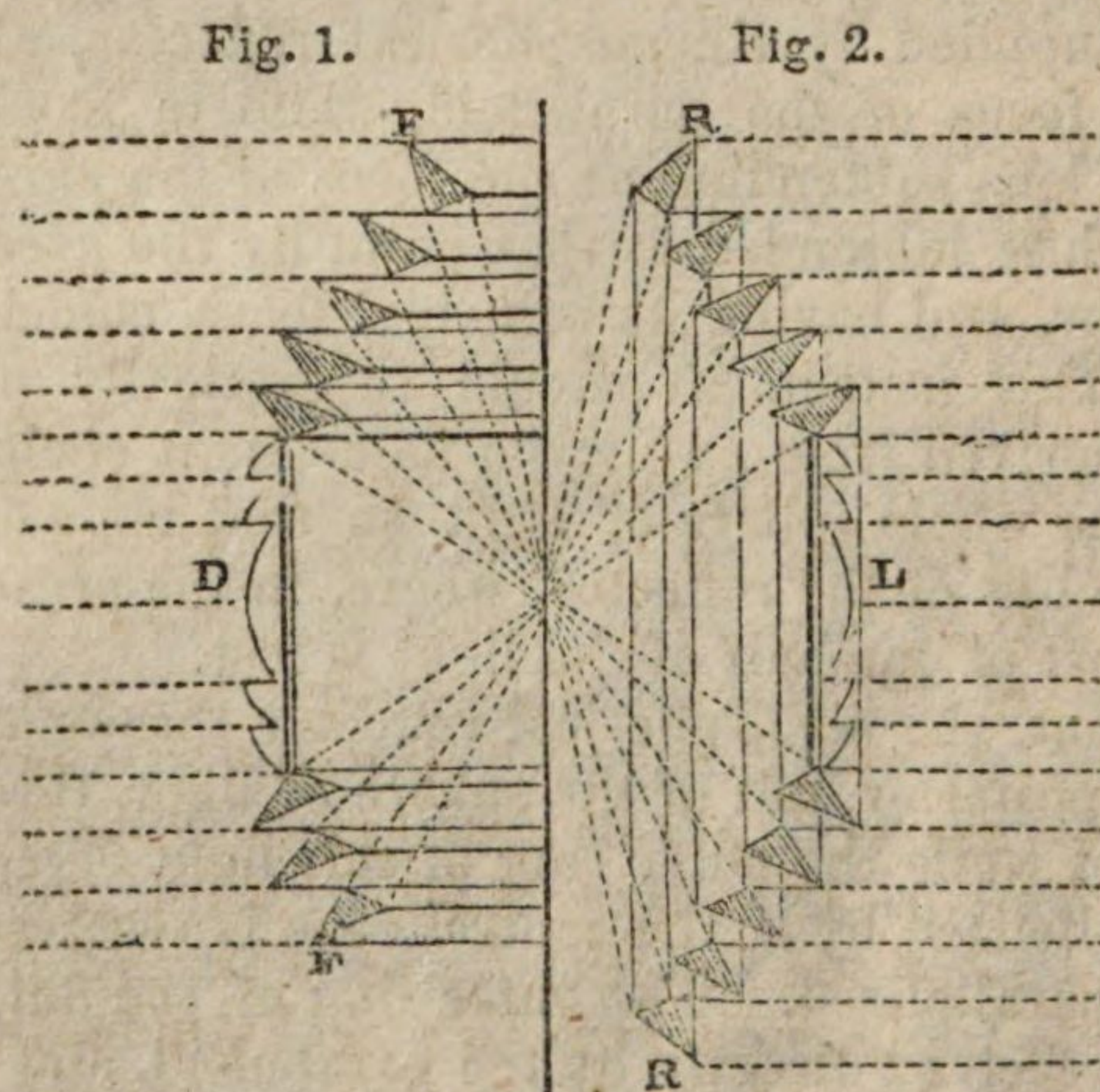
being the substitution of two truncated parabolic conoids for the paraboloid, and a refracting belt for the lens. Two of these instruments directed to opposite points of the compass would light up the whole horizon.

Another new form of light-house apparatus was also described, by which the whole sphere of rays can be parallelized by means of a hemispherical reflector placed behind the light, and an annular lens, and a series of concentric totally-reflecting glass zones, also placed in front, and receding from the lens back to the reflector. These zones are new in themselves, as they have the property of parallelizing divergent rays, not only in a vertical plane, like the zones of Fresnel's fixed lights, but also in every plane whatever.—*Proc. Roy. Scot. Soc. Arts.*

Extract from Journal of the Franklin Institute.

The chairman of the committee on meetings, Mr. George W. Smith, stated that during the last spring, when the various forms of dioptric apparatus for light-houses were submitted to the inspection of the members of the Institute, he was enabled to suggest an improvement of which the system was susceptible. This improvement had been, at the time, exhibited to a number of light-house engineers and men of science, both in this country and in Europe. As it had been deemed practicable by a number of these gentlemen, he now submitted it to the Institute for examination.

It is known that, *originally*, the cupola, or that part of the apparatus *above* the drum or system of lenses of Fresnel, consisted of mirrors which reflected the light passing upwards towards the horizon. In the *fixed* lights, the zones of mirrors of the cupola have been advantageously succeeded by horizontal catadioptric rings of glass, refracting and totally reflecting the light uniformly in every azimuth; but in the revolving lights, these mirrors (which are not in harmony with the residue of Fresnel's beautiful system) are still retained, and occasion a diminution of light which might be prevented.



Thus, in fig. 1, (which is the left hand *half* of a vertical section of a dioptric *fixed* light,) D is the drum, and F F are the catadioptric *horizontal* rings of the cupola, refracting the light proceeding from the radiant point or lamp in the focus to *every* point in the horizon.

Fig. 2 is the right hand *half* of a vertical section of a dioptric revolving light, or of a light which is to be thrown only in one direction at the same moment. L is the great annular lens; R R, the catadioptric rings arranged in vertical parallel planes, which unite their beams with those of the great lens, L, and project them in the same direction, without the intervention of the small inclined lenses of the cupola heretofore used, with their accompanying inclined mirrors. With revolving lights of eight sides, of course *only segments* of these rings would be used;—a system of segments for each division of the cupola, as well as for the portions below the great lenses if expedient.*

When a powerful light is required in only one, or in two directions, to mark a channel, *complete* rings will be suitable; the spherical reflectors of Fresnel may be used as auxiliaries. As a few persons have imagined that there is a risk in the employment of a single lamp in the Fresnel lights, the extinction of which would leave the horizon in darkness, and thereby jeopard navigation, although this risk is extremely small, Mr. Smith concluded by stating that, if this improvement of the vertical rings be adopted, four or eight such apparatus, of a smaller size, but of an equal intensity in the aggregate, might be arranged on the horizontal arms of a Greek cross, each throwing the light in two opposite directions, and the whole revolving; a central fountain supplying the lamp in each apparatus with oil, or each might be furnished with a mechanical lamp, such as Carcel's. If the lamp, with several concentric wicks, consume more oil for a given amount of light than lamps with single wicks, this arrangement might economize the oil, but no opinion is expressed on the latter point. Such small apparatus would require less glass, and have less weight, than those on the plan now in use; the lamps would require no more care than the ordinary fountain lamps; the propriety, however, of substituting a number for the single one now employed, was submitted merely for discussion, without pressing any claim for superiority.

Prof. Cresson remarked that he concurred with the chairman as to the effects which he had stated to the meeting would result from the adoption of the vertical rings in lieu of the small lenses and reflectors now in use, and desired that a copy of the plan might be deposited in the Institute, which was assented to.

Mr. Smith proceeded to make some remarks on the usual mode of estimating the economical value of the various methods of illumination, viz., by the intensity of the light, as measured by the photometer, compared with the consumption of material in a given time. He remarked that, although this method was sound in principle if all the circumstances were taken into consideration, yet it frequently led to incorrect conclusions when they were neglected. Thus if a building were to be lighted by a number of suspended lamps or by gas, suppose the intensity of a given number of the lamps and gas burners, measured as just mentioned, to be equal, the light given by the lamps actually would be less, in some cases, by 14 per cent., in consequence of the interception of a portion of the light by the body of the lamps, while, with *suitable* gas burners, little or no light is intercepted. Many gas burners are, however, deprived of this advantage by cups, flowers, or other ornament, injudiciously added beneath the jets.

* The rings near the vertical central line are not represented, their section not being in the same plane.

APPENDIX P—No. 1.

Account of the Holophotal system of illuminating Light-houses; being a description of optical apparatus for producing a light of maximum intensity: by THOMAS STEVENSON, F.R.S.E., V.P. R.S.S.A., civil engineer. (From the transactions of the Royal Scottish Society of Arts.) With an appendix.

KEITH GOLD MEDAL OR PLATE, VALUE THIRTY SOVEREIGNS, AWARDED NOVEMBER 1, 1850.

The principle of virtual velocities in dynamical science teaches us that whatever power is applied at one end of a machine will be given out, diminished by friction, at the other end, so that the theory of a perpetual motion, or, what is the same thing, of an apparatus capable of generating power, will not bear the scrutiny of a sober investigation. As in dynamics we cannot create power by any system of mechanism, so in optics we cannot by any arrangement of instruments, however ingenious, ultimately give out more light than what proceeds originally from the flame. All we can do, therefore, to obtain the maximum effect of a flame of given intensity is to transmit all its rays in the required direction with the least possible loss from absorption or irregular scattering. It is important to recollect these views when considering the application of optical principles to the illumination of light-houses.

Optical apparatus used for fixed lights, which are constantly visible all round the horizon.

Let us suppose that it were required to illuminate every part of the sky, the horizon, and the sea at the same instant of time, or, what is a better illustration, suppose it were required to illuminate simultaneously the whole interior surface of a hollow sphere, it is obvious that a single taper, or rather a luminous point unassisted by any optical instruments, but casting its divergent rays in every plane, is the proper and indeed the only means by which the conditions postulated can be fulfilled, and it is also evident that such an arrangement fulfils those conditions *perfectly*. Such a case as that supposed cannot, however, occur in the practice of light-house engineering; for although it may be desirable to light the whole horizon, it never can be required to illuminate either the sky or the waters of the ocean. The kind of light on which the largest demands are made is what is termed the *fixed light*, which if erected on a rock or in an insular position may, and generally does, require to exhibit a light of constant brilliancy simultaneously all round the horizon. In such a case, to revert to the illustration of the hollow sphere, no light is required near the poles, which are dark, but it is necessary that an equatorial belt of a certain breadth should be lighted up. The light, therefore, which was formerly expended in illuminating the poles, may now be bent downwards from the superior, and upwards from the inferior pole, in order to contribute to the intensity of the luminous equatorial belt.

Fresnel's fixed dioptric light may be considered as *perfectly* fulfilling the conditions we have just described for a fixed light. This apparatus is

shown at figs. 11 and 12, where f is the flame, R is what has been termed the cylindric refractor, and p are the totally reflecting prisms. The cylindric refractor is the solid which is generated by the revolution of the middle vertical section of an annular lens round its vertical axis. Such a hoop of glass, while it possesses no refractive action horizontally, will have such an action in the vertical plane, so as to give out in every azimuth a vertical strip of light, whose breadth and height depend upon the size of the flame and the height of the refracting hoop itself. The totally reflecting prismatic rings p , are intended to act upon the light which would otherwise escape *above* and *below* the cylindric refractor, so as to make such light available like that portion which falls upon the refractor itself. These prisms are the solids which are generated by the revolution of triangles of certain forms round the vertical axis, which pass through the focus of the cylindric refractor. The positions and forms of these zones are determined on the principles of refraction and *total reflection*. The diverging rays falling upon the first or inner side of the zone are refracted, and pass on to the second or upper side, where they suffer total reflection and then emerge after a second refraction at the third or outer side of the zone. The effect of the zones is to lengthen, both upwards and downwards, the vertical strip of light produced by the action of the cylindric refractor, and thus there is given out in every azimuth a vertical strip of light, whose size depends on the breadth of the flame and the height of the apparatus.

Optical apparatus hitherto used for revolving and leading lights.

Where numerous light-houses are required on any line of coast, it becomes necessary to resort to some expedients for distinguishing one from another. Such are the different modifications of revolving and colored lights. In some situations, also, there is no occasion for lighting up the whole horizon. In leading lights, for example, two towers, whose lights are visible in one azimuth, are all that are required for producing the desired effect.

For both revolving and leading lights the parabolic reflector has long been in use, and for revolving lights the lens system of Fresnel has been recently much employed. The characteristic requirement of a revolving light is the alternation of light and darkness in every azimuth. In the catoptric system this is generally effected by means of a revolving frame on which the reflectors are placed, each having its own lamp attached to it. Whenever, by the revolution of the frame, the axes of the reflector is pointed to the eye of a distant observer, he receives the full effect of the light. From this description, it is obvious that, if the revolving frame has four, six, or eight faces, there will be constantly illuminated four, six, or eight corresponding portions of the horizon. The action of the optical agents in this instance must obviously differ from that required in the fixed lights. For the fixed light the bending of the diverging rays so as to become parallel to each other was confined to the vertical plane; whereas in the revolving light, the lenticular action, or that by which the diverging rays are rendered parallel, extends to every possible plane, including the horizontal and the vertical, so that while the fixed apparatus gives only a *sheet* of light, the revolving gives a *beam* of parallel rays.

If a radiant point be placed in the focus of a paraboloidal reflector, a , fig. 1, each diverging ray which falls upon its surface will, as is well known, be thrown forward parallel to the axis, for a tangent to the parabola makes

equal angles with the diameter which passes through the point of contact and a straight line drawn from that point to the focus. It must be obvious, however, that this instrument is a very imperfect one. The diverging rays which are intercepted by it are little more than what emanate from the back part of the flame, and not very much short of one-half of the whole sphere of rays escapes by natural divergence past the lips of the reflector. It is a fact which is perhaps little thought of, but the greater part of the light which reaches the eye of the mariner from our catoptric lights emanates from the back of the flame, or that side which is turned *from* him; while those proceeding from the side which is turned *towards* him, escape by natural divergence, and never reach his eye.

In the revolving dioptric apparatus of Fresnel, shown at fig. 19, the same object is attained by means of one large flame, surrounded by a revolving frame carrying a given number of annular lenses, *L*. Those lenses are nothing more than burning-glasses on a large scale, built in separate concentric rings, in such a way as to avoid as much as possible loss of light from absorption. As the rings have different curvatures, the effects of spherical aberration are also to a great extent corrected. Fresnel introduced a compound arrangement of lenses and silvered plane mirrors, *a* and *b*, to intercept the diverging rays which pass above the lenses; while below the lenses there is added a series of totally reflecting prisms, *p*, exactly similar to those already described for the fixed light. Such an instrument cannot, then, be described as strictly a revolving light, for, while the lenses and upper portion will produce a revolving light, the zones below will show as a fixed light. On this account, the revolving dioptric apparatus hitherto employed cannot, like the apparatus for the dioptric fixed light already described, be regarded as *perfect*. The loss of light produced by the compound arrangement of lenses and silvered mirrors above the lenses must also be very considerable, the loss by absorption from metallic specula being generally believed to be not less than *one-half* of the whole incident light.

Metallic Holophotal reflectors.

The great loss of light by natural divergence in the parabolic reflector, and the separation of the rays into as many portions as there are lenses in the frame, in Fresnel's revolving dioptric apparatus, together with the objectionable plan for intercepting the rays which pass above and below the lenses, led me some years ago to inquire into the possibility of increasing the intensity of our lights by changes in the optical arrangements. The problem which I assigned to myself was the following:—Suppose a box containing a lamp, and having only one hole of given dimensions cut in one of its sides, let it be required so to enclose the lamp, with apparatus capable of modifying the directions of the rays, as *avoiding all unnecessary refractions or reflections, to cause the whole diverging sphere of light which proceeds from the flame to pass ultimately in one parallel beam through the aperture in the side.** Such a light I have called the "*Holophotal*," or *light of maximum intensity*.

This effect is produced by the combination of an annular lens, *L*, figs. 3 and 4; a parabolic conoid, *a*, truncated at its parameter; and a hemispherical

* *Vide* Sir D. Brewster's article, "Burning Instruments," in the Edinburgh Encyclopædia, for the best method formerly proposed of sending forward divergent rays by means of a combination of numerous small lenses and plane reflectors.

mirror, *b*. The lens, when at its proper focal distance from the flame, subtends the same angle from it as the outer lips of the paraboloid. The hemispherical reflector occupies the place of the parabolic conoid which has been cut off behind the parameter. The flame is at once in the centre of the hemispherical mirror and in the common focus of the lens and paraboloid. Suppose the whole sphere of rays emanating from the flame to be divided into two portions, viz: the hemisphere of front rays and the hemisphere of back rays; part of the anterior hemisphere of rays is intercepted by the lens and made parallel by its action, while the remainder is intercepted by the paraboloidal surface, and made parallel by its action. The rays forming the posterior hemisphere, and which fall upon the hemispherical reflector, are sent back through the focus in the same lines, but in directions opposite to those in which they came, whence passing onwards they are in part refracted by the lens, and the rest are made parallel by the paraboloid. The back rays thus finally emerge horizontally in union with the light from the anterior hemisphere. This instrument, therefore, fulfils the conditions prescribed by collecting the *entire sphere of diverging rays into one parallel beam of light*.

The first instrument which I had constructed upon this principle, was for the North harbor of Peterhead, and has been in use since August 1849. Mr. A. Stevenson has also introduced an instrument of this kind on a large scale, into HOY SOUND LIGHT-HOUSE, one of the Northern Lights stations.*

Experiments were lately made at Gullan Hill on the comparative power of a brass reflector on this principle, and a highly finished silver reflector of the usual construction, both instruments being twenty-five inches in diameter at the lips. The lights were viewed at distances of from seven to twelve miles every night during a week, and *in every instance the brass reflector on the holophotal principle had the advantage of the silver reflector, although it cost only about half as much as the other; and on one occasion, when the atmosphere was thick, the light from the holophotal brass reflector was alone visible*. As the great objection to red, green, and other colored lights, is the enormous loss by absorption, the holophotal arrangement seems specially adapted to all lights which pass through colored media.

Another modification of the holophotal metallic reflector still remains to be described. The execution of such an instrument as that shown in figs. 3 and 4, if of a large size, is necessarily attended with considerable difficulty. To remedy this evil, as well as to render the instrument smaller and more compact, I have recently had reflectors made of the form shown in figs. 5 and 6. This plan consists of the union of two or more paraboloids, each having a different focal distance with a spherical mirror and a lens. By this arrangement, the whole light is rendered parallel, in the same manner as in the instrument first described.†

* At Hoy sound there are two leading lights, the highest, which is of a red color, requiring to be visible a great distance seaward. The Hoy reflector is of a very great size. It measures 45 inches across the mouth, the lens is $11\frac{1}{2}$ inches in diameter, and the light is produced by a double wick-burner.

† A small temporary light for Morecambe harbor, Lancashire, is now being made of this form.

Totally reflecting Holophotal apparatus, substituted for the metallic paraboloid.

In so far as concerns the arrangement of the different parts, irrespective of the nature of the materials of which they are composed, the light emitted from any given flame by the instruments just described, should be the light of *maximum intensity*. But, as already stated, the most accurate experiments which have been undertaken by scientific observers, have shown that reflection from the best silvered mirrors, and even from metallic specula, made with the utmost care for experimental purposes, involves a loss of light by absorption of not less than about one-half of the whole incident rays.*

The advantage of employing as largely as possible the principle of *total reflection* from glass, in place of ordinary reflection from metallic specula, induced me to attempt further improvements in the holophotal system of illumination. M. L. Fresnel found that the totally reflecting prisms, *p*, figs. 11 and 12, of fixed lights were superior to the silvered mirrors which were formerly in use, in the proportion of 140 to 87.† It occurred to me that it might be possible to construct totally reflecting prisms so as to obtain a lenticular action in *every* plane. In the holophotal apparatus, figs. 3 and 4, if we retain the lens and the spherical mirror, and in place of the paraboloid, we conceive the arc between the lens and spherical mirror to be filled up with glass rings, which are the solids of revolution generated by the rotation of the cross section of the totally reflecting prisms used in fixed lights, round a horizontal axis passing through the flame, we shall then have succeeded in *extending the action of the lens, so as to parallelize one-half of the whole sphere of incident rays.*‡ Such an arrangement is shown in figs. 7 and 8, where *L* is the lens, *p* the totally reflecting prisms, and *b* is the spherical mirror. The distinguishing peculiarity of this arrangement is, that the prisms, instead of transmitting the light in parallel vertical plates, diverging all round as in the fixed light apparatus of Fresnel, (figs. 11 and 12,) produce an extension of the lenticular or *quaquaversal* action of the common annular lens, by assembling the light around its axis in the form of concentric hollow cylinders. In order to distinguish this system of prisms from those introduced by M. Fresnel, which have no lenticular action, they may therefore be termed “holophotal” or “catadioptric lenses.”

Holophotal apparatus, consisting entirely of glass, and acting by refraction and total reflection only.

I shall now describe a method of replacing the hemispherical reflector of metal or silvered glass, by means of a polyzonal totally reflecting hemisphere of glass, *vide* fig. 9. By this arrangement reflection from metallic specula is abolished from every part of the system, and the principles of total reflection and simple refraction are substituted.

The action of these glass zones will be best understood by referring to fig. 10, which gives the cross section of one of them; *f* shows the flame

* *Vide* Brewster's Optics.

† *Vide* Treatise on Illumination of Light-houses, by Alan Stevenson, LL.B., F.R.S.E., Civil Engineer. John Weale, 1850.

‡ These prisms might perhaps be extended in number so as to take in even more than the half sphere of rays.

or centre of the system, and the diverging rays are represented by dotted lines, the arrows indicating the direction of one diverging ray before and after being altered by the prism. The side bc is concave, the centre of curvature being in f , the centre of the flame. The surfaces of the other sides, ab and ac , are portions of parabolas whose common focus is f , or of circles osculating the parabolic curves. Those parabolic surfaces face each other, and their tangents form an angle of 90° with each other at the vertex of the prism. Any ray proceeding from the centre, f , will be received as a normal to the surface bc , and will consequently pass on without suffering any deviation from e , where it meets the prism, to its incidence on the surface ab , where it will be totally reflected in the direction rr' , tangential to the sphere at the axis of each zone. At r' it again suffers total reflection, and finally emerges in a radial direction without deviation at the point e' . An exactly similar action will take place simultaneously with another ray in the same path from the flame, though passing in an opposite direction. The concentric zones, a , which compose the dome, *vide* fig. 9, are solids of revolution, generated by the rotation round the horizontal axis of the instrument of triangles similar to abc , fig. 10, with a radius equal to af . The angle formed by the radius with the horizontal axis of the instrument varies from nearly 90° down to zero, as shown in fig. 9. Where those angles vanish at a' , a conoid will result, having the radius of its base equal to the semichord of its inner surface. The formulæ for calculating such zones, by Mr. William Swan, who has kindly rendered me much assistance in prosecuting this part of the subject, are now being printed in the Society's Transactions. The prisms bac , resemble in their action that of the drops of rain which give rise to the natural phenomenon of the rainbow. From this peculiarity, these zones may be distinguished by the name of "*rainbow prisms*." In fig. 9, which shows the whole instrument complete, L represents the common lens acting on the rays by refraction only; p the catadioptric portion of the lens acting by refraction and total reflection; and $aa'a$, the "*rainbow prisms*" acting by total reflection only. Should the execution of the hemispherical dome be attended with success, the effect will be striking, as no direct light from the flame should be visible behind the apparatus, although the screen interposed is but of transparent crystal. When in Paris in March, 1850, I had an opportunity of showing a model and drawings of this apparatus to M. Fresnel, and also to M. Letourneau, the manufacturer of the French lenses. M. Fresnel was of opinion that *theoretically*, it was wholly without defect, although the execution might be found troublesome.* Mr. John Adie, optician, is at present engaged in the construction of a complete apparatus on this principle, the diacatoptric lenses having been already finished.

Alteration of the common Parabolic Light-House reflector to the Holophotal system.

To render holophotal the ordinary reflectors which are still much used in light-houses, let there be cut off (*vide* fig. 2,) a small portion, a', a' , behind the parameter, substituting a portion of a spherical mirror behind, and adding a lens, L , with three diacatoptric lenticular rings. The Horsburgh

* It is worthy of remark that in this instrument there is no loss of light by superficial reflection.

light-house, now being constructed on the Pedro Branca rock, near Singapore, according to plans by Mr. J. T. Thomson, government surveyor, was lately fitted up with apparatus on this principle, under the direction of Mr. A. Stevenson*. It consists of a frame having nine holophotal reflectors of this kind. A similar apparatus is now being made for the new harbor light of Pulteneytown.*

Alteration of Fresnel's revolving light to the Holophotal system.

Fig. 20 shows the adaptation of the holophotal system to Fresnel's revolving light of the first order which is now in such general use; L are the lenses, and P the catadioptric lenticular rings. The advantage of this system will clearly appear by comparing it with Fresnel's apparatus, (fig. 19.) I have projected, at each of figs. 19 and 20, proportionate sections, marked $x y$, of the beams of light which are given out by the two kinds of apparatus. The objectionable arrangement of the lenses and mirrors a and b , (fig. 19,) by which one-half of the light is lost, is also done away with.

SUPPLEMENT.†

Since the foregoing account was written, the following plans have occurred to me as being useful in some situations:

Method of lighting without the Spherical Mirror.

In figs. 13 and 14, which show an elevation and middle horizontal section of the apparatus, L is the lens and P the reflecting diacatoptric rings similar to those already described. The posterior hemisphere of rays is received upon two complete sets of half lenses and half rings, marked L' and P' respectively. This apparatus renders parallel the back rays, and sends them in two beams on either side of the lamp, where they fall upon a series of straight right-angled prisms, $p p$, by which the directions of the emergent rays are altered, so as to be at right angles to the emergent rays. Figs. 15 and 16, show an adaptation of this plan to an ordinary-sized reflector, which does not require separate explanation. M M are silvered plane mirrors.

* The reflector for Pulteneytown is constructed of zinc, which forms a cheap substitute for silver. I have also had made for me a porcelain reflector, $6\frac{1}{2}$ inches diameter, of what is called "lustre ware," which gives a good light, and requires no polishing. Were plane circular discs, or portions of hollow spheres (which are the best forms) constructed of this material, and fixed in the top or cover of our street lamps, the light which now escapes upwards might, at a very trifling cost, be usefully directed downwards to the street.

† This supplement was written subsequent to the report of the committee of Society of Arts, which is appended to this paper.

Holophotal Quadrant.

No want probably presents itself more frequently in the course of lighthouse engineering, than an apparatus possessing a greater divergence than the ordinary parabolic reflector which illuminates about 15° . Where half the azimuth is to be illuminated, nothing can be better than half of Fresnel's apparatus (figs. 11 and 12.) In situations, however, where smaller arcs are required, much light must be lost, unless recourse is had to several parabolic reflectors, which are expensive both for first cost and annual maintenance. What is most wanted is a holophotal arrangement, capable of illuminating a quadrant of a circle. Such an arrangement is shown on plan and middle horizontal section, by figs. 17 and 18, in which f represents the flame; and $a a' a'$, a quadrant of one of Fresnel's fixed light apparatus (of which a complete one is shown at figs. 11 and 12;) p and p' are prismatic half rings, of a peculiar form, arranged vertically round the flames as a centre, and b is a hemispherical mirror placed behind.

The action of Fresnel's quadrant, as already described, is to scatter equally in the horizontal plane throughout the quadrant, all the light which falls upon it. The prismatic semi-rings, p and p' , possess the property of diverging all the rays that fall on them, so as to cause them to emerge parallel to their corresponding or complementary rays which emerge from Fresnel's apparatus. Those marked p' , send out rays parallel to the different rays which pass out of the half of the quadrant $a' a'$, which is on the side opposite to them; while those marked p , send out rays corresponding to those from the side $a a$. This will be best seen by comparing the paths of the different rays individually. The prismatic rings are straight on the totally reflecting side, concave on the immerging side, and convex on the emerging side. The centre of curvature for the immerging side is the centre of the flame, so that the diverging rays will enter as normals to that surface without undergoing any deviation, and will continue to diverge. On reaching the straight side, each diverging ray will be totally reflected at right angles to its former direction, and will pass on, each diverging from the other, as before, to the emerging side. The radius of curvature from this last side must be such, that each diverging ray will be a normal to the surface generated, and therefore that surface must be equidistant from the focus, as measured at any point along the track of the diverging rays. Each diverging ray must, in short, traverse the same distance between the radiant point and the surface of emergence. The point of junction of the emergent and reflecting sides of each prism (which is the exterior corner of the prism) will therefore be equidistant from the centre of curvature of the emergent or convex side and the centre of the flame; and the lines joining those centres with the exterior corner of the prism will be at right angles to each other.

As a very large proportion of existing lights, more especially harbor lights, do not require more than a quadrant, but have half of Fresnel's apparatus, it may be mentioned that such lights can, although at a disadvantage compared with the plan just described, be rendered holophotal by simply placing in front of them *straight* right-angled prisms, having similar cross-sections to those above described, for the circular prismatic rings marked $p p'$ in fig. 18.*

* If metallic reflection be used instead of total reflection, where there is only a quadrant of Fresnel's apparatus used, the position and form of the strips will be the same as that of the straight sides of the prisms marked $a a'$ in fig. 18.

This kind of apparatus will, I am persuaded, be found to be of very general utility, and to be especially convenient in situations where it is desirable to *mask* or cut off the light in some one definite azimuth,—to cut off, on a sharp bearing, the light proceeding from an ordinary parabolic reflector or lens, being, in practice, a most difficult and unsatisfactory problem.

The reversing light, being a substitute for reciprocating lights.

Where only one-half or less of the horizon requires to be illuminated by a revolving light of the common construction, it is obvious that, while one-half of the reflectors on the revolving frame are pointed usefully towards the sea, the other half must be uselessly illuminating the landward side. In order to save this unnecessary expenditure, Captain Smith, of the Royal Engineers, proposed what he termed a reciprocating light. This plan was to place reflectors on only one part of the frame, and to give the frame a reciprocating, instead of a uniform, circular motion. In this way, one-half of the number of reflectors answers the purpose of illuminating the seaward arc, while there is no light whatever shown towards the land. This plan, however, is open to very grave objections, inasmuch as the distinctive character of a revolving light is no longer preserved; the alternations between light and darkness being equal only in the middle of the arc, and varying towards the two extremities. Such an arrangement is therefore fraught with the greatest risk of confusion, seeing that it presents ever varying characteristics according as the observer passes from one azimuth to another, and hence the risk of confusion and mistaking the light for another cannot be avoided.

To effect the same economy which the reciprocating light secures, and, at the same time, to obviate the disadvantages referred to, the following plan will, I think, be found in every way suitable. Fig. 21 shows a ground plan of the apparatus, in which A B C D represent the frame, having toothed segments on its periphery. R is the reflectors and lamps, which have a vertical spindle passing through their common centre of gravity. On the lower end of this spindle, a small pinion wheel *e*, shown in dotted lines, is attached, and on separate standards there are two concave toothed segments E F, placed at the same level as the pinion wheels, and at opposite points of the circle. Let it be supposed that the side which is to be illuminated is the half of the horizon marked G H D, which is next the sea, while the landward side, D J G, is to be kept dark. As the frame A B C D is made to revolve by the ordinary machinery of the light room, working on the large toothed wheel at the point K, the reflectors will have their directions reversed whenever the pinions at the end of their spindles come into gear with the fixed concave segments, E F. The reversing segments E F, have just as many *leaves* as are sufficient to turn the reflectors backward through an arc of 180° ; and to prevent any casual obstruction from causing the reflector to alter its position before it reaches the other reversing segment, a small spring acting as a *pall*, secures it in the exact position which has been given to it by the last tooth of the segment. It is hardly necessary to observe that one large reflector may be made on the same principle to illuminate half of the horizon.

From the description which has just been given, it will be very easily seen that the reflectors will be arranged as if on the *outside* of a cylinder

while they are on the seaward arc, and on the *inside* of a hollow cylinder while they are on the landward arc. Each reflector and lamp is turned with its face toward the centre of the apparatus on coming into gear with the fixed segment E, and with its back to the centre on coming into gear with the fixed segment F. I think it proper to mention that I have been favored with the sight of an elegant and ingenious plan for effecting the same objects, by Mr. J. T. Thompson, Government Surveyor, Singapore. As I do not consider myself at liberty to give any description of this instrument, I shall merely mention that it appears to me to be well suited for fulfilling the required conditions, although not perhaps so rigorously as the plan above described, and certainly not so simply.

Apparent lights.

I take the present opportunity of throwing out some hints on the possibility of causing a light, for the use of the mariner, to appear as coming from a position different from its real one. The reader is no doubt familiar with the many sunken rocks which have proved of great danger to shipping, and which have hitherto, from their limited size, defied all attempts to erect light-houses upon them. A large number of our tidal harbors have their light-houses erected not on the seaward extremity of their covering breakwaters, where they would be undoubtedly of most value to vessels taking the harbor, but on the inner piers or even in landward situations. The cause of such localities being preferred is from the greater amount of shelter which they possess. It has always been regarded as an axiom in light-house engineering, that it is better to have no light at all than to exhibit one whose appearance is doubtful, and on the certainty of whose exhibition the mariner cannot at all times rely. To establish a light at the extremity of the outer covering pier of a large number of our harbors, would be to place it beyond the control of the light-keeper during the prevalence of stormy weather, when its exhibition is of most value.

Several plans have been adopted or proposed for warning the seaman of his approach to hidden dangers, such as the tolling of bells by the waves, or by machinery acted on by the hydrostatic pressure of the tidal column, as proposed by the late Mr. R. Stevenson in 1808 for the Carr rock, and several preparations of phosphoric oils, and agents of a similar nature, have been attempted to be used.

Although unprepared to offer any decided opinion as to what extent the method may be available of employing light which is derived from distant sources, I may nevertheless observe, that it appears to be worthy of trial, whether light projected from a distant light-house could not be concentrated on some inaccessible rock, so as to be there acted on by optical apparatus placed in a hermetically sealed lantern. The great difficulty attending such a plan is the small divergence which the light would have after reflection; and where dioptric action was employed there would also be a risk of the light being disfigured by prismatic colors. These difficulties I have found to exist to a greater or less extent in repeated experiments which were begun in the month of January last. One of these experiments was an attempt to cast parallel rays, proceeding from a distant lamp, upon glass prisms placed in the same line with the observer's eye. The prisms were of the same cross section as the rings in Fresnel's lens; but were the solids generated by those cross sections moving parallel to the vertical axis

of the lens, instead of round its centre, which generates the solids in the concentric arrangement in the common lens. Where it is required that the apparent light should illuminate 180° , parallel rays from the emerging lens must be received upon a glass screen, which is the solid that would be generated by a cross section of the holophotal prisms and lens (figs. 7 and 8) moving parallel to the vertical axis of that apparatus. Straight rectangular glass prisms plane and spherical mirrors, were also tried for reflecting the rays in such a manner as to make them appear to proceed in a direction at right angles to the original direction.* The effect produced by plane mirrors or straight rectangular prisms seemed in every instrument to be nearly as good as the original light for very considerable distances, but the great evil, as might have been expected, was the limited arc in which the light could be seen. Without experiments upon a large scale, and attended with considerable expense, it would be difficult to decide to what extent such a system could be carried out; but for limited distances, such as could be easily had at many of our harbor mouths, or at beacons near the shore, I am inclined to think that apparent lights capable of indicating the position of the seaward pier-heads or sunken rocks, could be constructed without much difficulty. A most satisfactory trial was made in the Meadows, Edinburgh, when the emergent and immergent apparatus were 500 feet apart, and the light was seen in different azimuths at the distance of about 600 feet, although the night was so foggy that Inchkeith light could not be seen from Edinburgh. But for the intervention of trees the light might have been seen very much further. The immerging apparatus consisted of straight prisms, whose cross section was similar to those shown in figs. 7 and 8. Where it is desirable to make the apparent rays at right angles to the original rays, the original light might be concentrated as near as possible to a cylindric reflector placed in the mock-lantern. Where it is necessary to have the mock-lantern in line with the observer's eye and the original light, the mock-lantern might contain a pane of glass of a different color from the original light. This pane would probably be more useful if of a cylindric shape, and the rays might be made to converge, by placing a lens immediately in front of it.

Application of the Holophotal principle to Fresnel's "Fixed Light varied by flashes."

The fixed light varied with flashes was invented by A. Fresnel, and is produced by the revolution of straight prisms similar to those described above, in front of a fixed light, so as to give occasional flashes of greater brilliancy. Mr. Wilkins of London has exhibited an instrument of this kind, but possessing some improvements, at the great exhibition. Fig. 22 represents a section of his apparatus as taken from a recent publication called the "Illustrated Exhibitor," and fig. 23 represents the same effect produced by using the holophotal prisms (described p. 688.) In fig. 22, the upper and lower prisms *a* are fixed, and a frame containing alternately a cylindric refractor and a lens with straight prisms *b*, revolves round the interior apparatus. In fig. 23, the whole apparatus revolves. It consists of alternate portions of Fresnel's fixed light, fig. 11, 12, and of Fresnel's

* The rays were also made to converge to a point near to the focus of the apparatus in the lantern, instead of being transmitted in a parallel beam.

revolving light rendered holophotal, fig. 20. The catadioptric prisms may be arranged in a position slightly excentric from the lens so as to prolong the flash.

By comparing these two kinds of apparatus it will be seen that I can accomplish, with one set of holophotal prisms, *p*, fig. 22, what requires in fig. 23, two sets of prisms *a* and *b*. By making the prisms *a*, fig. 23, of the same form as those marked *p*, fig. 22, the second set of prisms *b*, fig. 23, are rendered unnecessary. The adoption of the holophotal system, in this kind of light, makes the apparatus much simpler, and a great saving of expense and a very considerable saving of light are effected.

Price of Holophotal Apparatus.

I have had instruments of almost all the different forms constructed for me; and since the substitution of either cast or hammered zinc for silver, where metallic reflection is employed, the price has been exceedingly low. A metallic apparatus for a harbor or railway light costs from about £1 upwards, according to the size and construction.

APPENDIX.

Report of Committee, appointed by the Royal Scottish Society of Arts, on a description of the Holophotal system of illuminating light-houses, by Thomas Stevenson, Esq., F.R.S.E., &c.*

EDINBURGH, October 5, 1850.

Your committee having met and carefully considered the paper remitted to them, and having also communicated with Mr. Stevenson, and examined the models which he has caused to be constructed, are of opinion that he has very satisfactorily established the four following improvements in the system of lighting:—

1. By an arrangement of a lens with two reflectors, the one a truncated paraboloid, the other a hemisphere, whereby all the rays diverging from the flame are rendered parallel, (figs. 3 and 4.)

2. By substituting for the truncated paraboloid several annular paraboloidal strips, having different focal distances, and so arranged round the flame as in combination with the hemispherical mirror and the lens, to render all the rays parallel. This arrangement appears to be a great improvement, from its compactness, (figs. 5 and 6.)

3. By the application of total reflection to the parallelizing of divergent rays in every plane, (figs. 7 and 8.)

4. By the application of two total reflections so as to produce by means of prisms the effect of the hemispherical mirror, thus rendering the whole divergent beam parallel by a lens and prisms, without the intervention of any metallic reflection at all, (figs. 9 and 10.)

Your committee are of opinion that these improvements are of the greatest value. Some of them are already in practical operation, and are

* The members of committee are Rev. P. Kelland, M.A. and F.R.S., London and Edinburgh, professor of mathematics in the University of Edinburgh; A. Bryson, F.R.S.S.A.; and William Swan, F.R.S.E., teacher of mathematics.

stated to be highly successful. The fourth mentioned improvement, which consists of the application of two total internal reflections, instead of a spherical metallic reflection, appears to your committee to be so simple and elegant in theory, and so promising as a practical improvement in light-houses, that they hope it will speedily be constructed.

Your committee feel warranted in recommending the society to testify their approbation of these improvements in the strongest form.

PHILIP KELLAND, *Convener*.

WILLIAM SWAN.

ALEXANDER BRYSON.

Formulae for constructing Mr. Thomas Stevenson's totally reflecting hemispherical mirror. By William Swan, F.R.S.E., F.R.S.S.A.*

Among the various arrangements of optical apparatus hitherto used in light-houses, there is none that possesses the property of collecting all the light which emanates from a flame, and transmitting it in a single beam of parallel rays. The most perfect of these arrangements, which were invented by Fresnel, were not intended to produce this effect; and the ordinary parabolic reflector, which at first sight might seem fitted to transmit all the rays in one direction, in reality fulfils this condition most imperfectly, as it leaves a large proportion of them to radiate in their natural directions.

The importance of the problem of transmitting all the light in a single direction will at once be seen when it is considered that there are only two ways in which it is possible to increase the apparent brightness, and, therefore, the efficiency of a sea-light. One is by increasing the intensity of the source of light, the other, by using to most advantage the light actually produced. Now Carcel's mechanical lamp, as adapted by Fresnel to light-house use, is an instrument so perfect, and produces so brilliant a flame, that we shall not probably soon have a better source of light than that which we already possess. The only available method for increasing the efficiency of our sea-lights is, therefore, to obtain the maximum effect of the mechanical lamp by transmitting all its rays in a single direction.

As there is positively no limit to the extent to which the brightness of sea-lights might be usefully increased, it is evident that, although we were in possession of a practically available source of illumination many times more intense than that which we actually employ, it would still be an object of the greatest importance to use it in the most advantageous manner.

My friend, Mr. Thomas Stevenson, in his recently invented holophotal arrangements, has afforded the means of transmitting all the rays emanating from a flame in a single direction; and a beam of light proceeding from one of them should, therefore, be brighter than that transmitted by any other species of light-house apparatus not fulfilling the same condition, provided the intensity of the source of light is the same in both cases.

This paper has relation, not to the holophotal system of illumination generally, but simply to a new and somewhat singular species of reflector invented by Mr. Stevenson, and which forms part of his apparatus.

The use of this reflector will be understood from fig. 1, which represents

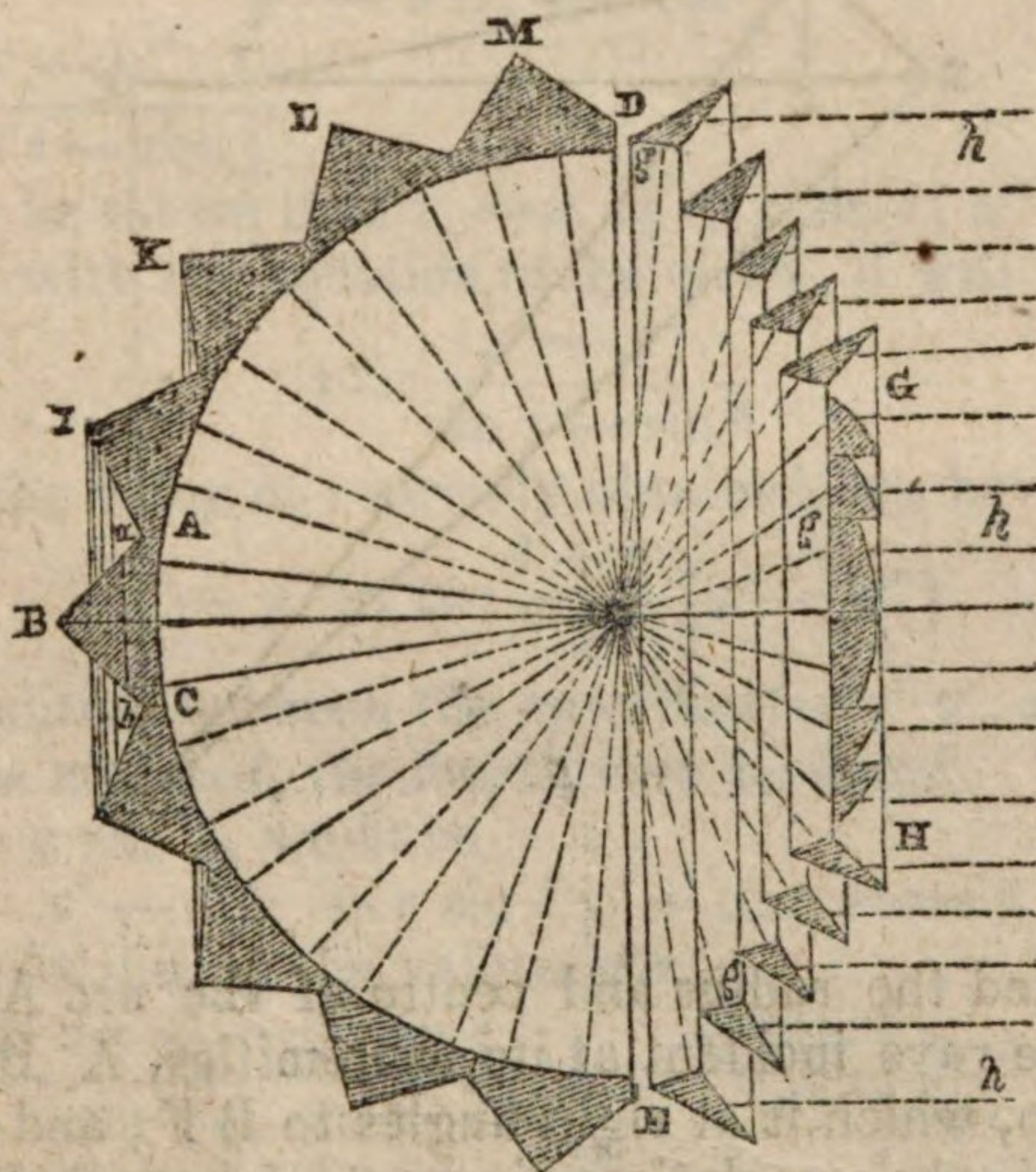
* Read before the Society of Arts, November 25, 1852.

a vertical section of one of Mr. Stevenson's holophotal arrangements. The holophotal apparatus in every variety of form consists essentially of two parts. One, D G H E, placed before the flame, which, in the apparatus shown in the figure, is a series of totally reflecting prisms, with a central polyzonal lens, possesses the property of transmitting all the rays F g, falling upon it in parallel directions, g h. The other, D B E, is a hemispherical mirror placed behind, with the flame in its centre; and its use is to collect all the remaining rays, which otherwise would be lost, and to reflect them back through the flame, so that they may fall on the apparatus in front in such directions as to admit of their being finally transmitted in the same parallel beam with the other rays.

Now, if this reflector were composed of polished metal, a large portion of the incident light would be lost by absorption; and Mr. Stevenson conceived the ingenious idea of substituting for a metallic mirror, a series of prisms of glass, by which the light, after suffering two reflexions, might be returned back to the radiant point. The object of this paper is to investigate formulæ for the construction of these prisms.

The *totally reflecting* mirror is represented in fig. 1, where D B E is a semicircle, divided into an *odd* number of equal arcs; a B, b B, are portions of parabolas having the common focus F, and the axis of each coinciding with the line D E; while I K L M are figures equal and similar to A B C. If, now, the figure D K B revolve round the axis B F, it will generate a solid of revolution, and this, when constructed of glass, forms the totally reflecting mirror.

Fig. 1.



It is evident that the portion of the light reflected from the surface generated by the revolution of the semicircle D A E, since it is everywhere incident at an angle of 90° , will be returned to the point F; and the rest of the light entering the glass at an angle of 90° will suffer no deviation by refraction. Let F a represent one of the rays. Then, since A B D is a parabola whose focus is F, and whose axis is D E, the ray F a, will be reflected in the direction a b, parallel to D E. Again, because B C is a parabola whose

circular arc, so that rays incident upon its extremities in given directions may be reflected in given directions. This problem may easily be extended to the case of a refracting instead of a reflecting surface; and as it may be useful in constructing other sorts of light-house apparatus, it may be proper to give a general solution.

Since the directions of the rays at the extremities of the arc are supposed to be known both before and after reflexion, it is evident that tangents to the arc may be drawn at these points.

Let the co-ordinates of the two extremities of the arc be $x' y'$, $x'' y''$, then the equations to the tangents at these points will be

$$y - y' = \tan \theta (x - x'); \quad y - y'' = \tan \gamma (x - x'')$$

where θ and γ are known.

Also the equation to the circular arc will be

$$(x - a)^2 + (y - b)^2 = r^2;$$

where r the radius of the circle, and a, b , the co-ordinates of its centre, are to be found.

The equation to the tangent to the circle at the point $x' y'$ is

$$(x - a)(x' - a) + (y - b)(y' - b) = r^2$$

and since this line is the same as $y - y' = \tan \theta (x - x')$ we have evidently

$$-\frac{x' - a}{y' - b} = \tan \theta$$

But since $x' y'$ is a point in the circle $(x' - a)^2 + (y' - b)^2 = r^2$, Therefore substituting for $x' - a$

$$y' - b = \pm r \cos \theta$$

In like manner we obtain

$$y'' - b = \pm r \cos \gamma$$

$$\text{Therefore } r = \frac{y' - y''}{\cos \theta - \cos \gamma}$$

Similarly it may be shown that $x' - a = \mp r \sin \theta$; $x'' - a = \mp r \sin \gamma$; from which, along with the equation to the circle, it will be found that

$$r = \frac{x' - x''}{\sin \gamma - \sin \theta}$$

From this and the value of r already obtained, we have

$$y' - y'' = \tan \frac{\theta + \gamma}{2} (x' - x'')$$

an equation of condition between the co-ordinates $x' y'$, $x'' y''$, from which, if three of them be assumed, the fourth may be found.

Next, to obtain a and b , we have

$$x' - a = -r \sin \theta \quad y' - b = r \cos \theta$$

from which, by substituting the values of r ,

$$a = \frac{x' \sin \gamma - x'' \sin \theta}{\sin \gamma - \sin \theta}; \quad b = \frac{y'' \cos \theta - y' \cos \gamma}{\cos \theta - \cos \gamma}$$

To apply these results to the case before us, making F the origin, and B F the axis of x , fig. 2:

The co-ordinates of A are $-x', y'$; and of B $-x'' 0$.

Therefore, in the preceding formulæ, putting $x' = -x'$, and $y'' = 0$

$$r = \frac{y'}{\cos \theta - \cos \gamma} = \frac{y'}{2 \sin \gamma + \frac{\theta \sin \gamma - \theta}{2}}$$

$$a = -x' + r \sin \theta$$

$$b = -\frac{y' \cos \gamma}{\cos \theta - \cos \gamma} = -r \cos \gamma$$

Also, putting $\downarrow$ for the whole angle which the breadth of one of the zones subtends at the point F, and d for the radius of the mirror measured from F to the point A, the angle $A F = \frac{\downarrow}{2}$, $x' = d \cos \frac{\downarrow}{2}$, and $y' = d \sin \frac{\downarrow}{2}$. Next, because the ray A F is reflected in the direction A C perpendicular to B F, $C A F = 90 - \frac{\downarrow}{2}$; and since the normal A D to the reflecting surface bisects the angle C A F, therefore $C A D = 45^\circ - \frac{\downarrow}{4}$.

Now, since A C and A D are respectively perpendicular to the tangent at A, and to the line B F, it follows that the angle C A D is equal to the inclination of the tangent to the line B F; therefore $\theta = 45^\circ - \frac{\downarrow}{4}$.

Again, because the ray A B is reflected at B in a direction at right angles to B F, the tangent at B is inclined at an angle of 45° to B F. Hence $\gamma = 45^\circ$. Therefore, substituting the values of θ , γ , x' , and y' , we obtain finally

$$r = \frac{d \sin \frac{\downarrow}{2}}{2 \sin \left(45^\circ - \frac{\downarrow}{8} \right) \sin \frac{\downarrow}{8}} \dots \dots (1)$$

$$a = -d \cos \frac{\downarrow}{2} + r \sin \left(45^\circ - \frac{\downarrow}{4} \right)$$

$$b = -r \sin 45^\circ$$

2. To find the radius of curvature on the supposition that A B is the osculating circle to a parabola at the point B.

It has already been shown that the true form of the arc A B is a parabola whose focus is F, and whose axis is a line at right angles to F B. Then F B is an ordinate through the focus, and the equation to the parabola will be

$$y^2 = 4 m z, \text{ where } F B = 2 m;$$

so that m is determined by assigning the diameter of the mirror from the flame to the outer edges of the zones.

From the equation to the parabola

$$\frac{dy}{dx} = \frac{2m}{y}; \text{ and } \frac{d^2 y}{dx^2} = -\frac{4m^2}{y^3}$$

Then, if r is the radius of curvature,

$$r = \pm \frac{\left(1 + \frac{dy^2}{dx^2} \right)^{\frac{3}{2}}}{\frac{d^2 y}{dx^2}} = \frac{\left(1 + \frac{4m^2}{y^2} \right)^{\frac{3}{2}}}{\frac{4m^2}{y^3}}$$

$$= \frac{2(x+m)^{\frac{3}{2}}}{m^{\frac{1}{2}}}$$

and if a and b are the co-ordinates of the centre of curvature,

$$y - a = - \frac{1 + \frac{d y^2}{d x^2}}{\frac{d^2 y}{d x^2}} = \frac{x y}{m} + y$$

From which $a = - \frac{2 x^2}{m}$

also $b x = - \frac{d y}{d x} (y - a)$

Hence $b = 3 x + 2 m$

But at the point B, $x = m$ therefore substituting, we obtain

$$b = 5 m; a = -2 m; r = 4 m \sqrt{2};$$

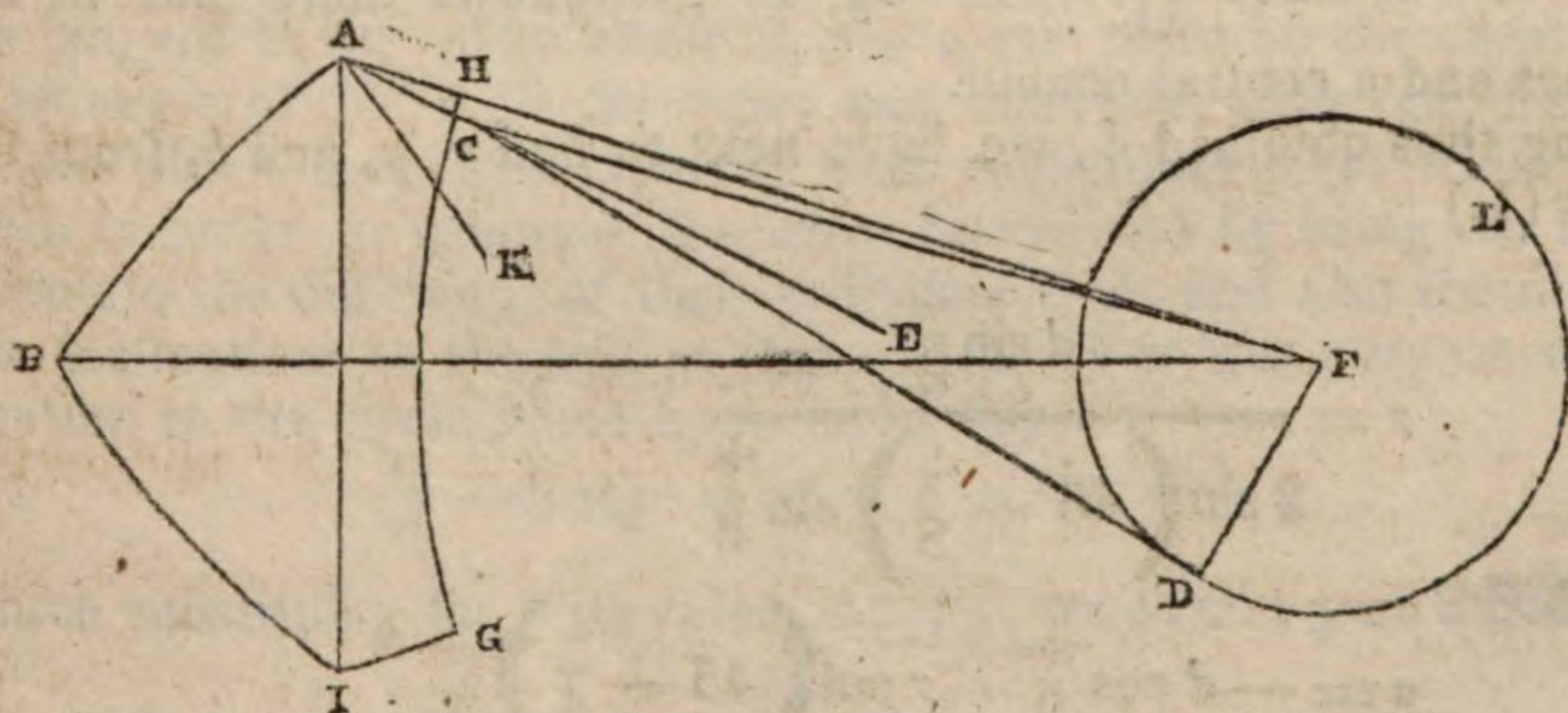
and if the origin be now transferred to F, so as to have the same axes as formerly,

$$b = -4 m; a = 2 m; r = 4 m \sqrt{2} \quad . \quad . \quad (2)$$

II. Determination of the greatest breadth of the zones consistent with the total reflexion of the incident light.

We have still to ascertain the greatest value of $\downarrow$ consistent with the total reflexion of all the incident light; and in determining this it is necessary to take into consideration the diameter of the flame, an element which has not entered into the previous calculations.

Fig. 3.



Let A B G H, fig. 3, be a section of one of the zones, D L a section of the flame, and D C A the course of a ray proceeding from the edge of the flame to the point A. Produce A C to E, join C F. Draw D F at right angles to C D, and A K a normal to the circle A B.

Then putting $C F = d$ as before, $F D = f$, and $\mu =$ the index of refraction of the glass for the extreme red rays of the spectrum.

$$\sin F C D = \frac{f}{d}, \text{ but } \sin F C E = \frac{1}{\mu} \sin F C D = \frac{f}{\mu d}; \text{ and } C A F = F C$$

$E - A F C = F C E$ nearly, neglecting $A F C$ on account of its smallness.*

Therefore $C A F = \sin^{-1} \frac{f}{\mu d}$. But since the ray $F A$ is reflected in the direction $A I$ perpendicular to $F B$, if $A K$ be a normal at A ,

$$\begin{aligned} K A H &= \frac{1}{2} I A = 45^\circ - \frac{\psi}{4} \\ \text{and } C A K &= K A H - C A H \\ &= 45^\circ - \frac{\psi}{4} - \sin^{-1} \frac{f}{\mu d} \end{aligned}$$

But if the ray $C A H$ totally reflected

$$\sin C K A > \frac{1}{\mu}, \text{ or } \sin \left\{ 45^\circ - \frac{\psi}{4} - \sin^{-1} \frac{f}{\mu d} \right\} > \frac{1}{\mu}$$

Therefore the equation of condition to insure the total reflexion of all the rays is

$$45^\circ - \frac{\psi}{4} > \sin^{-1} \frac{1}{\mu} + \sin^{-1} \frac{f}{\mu d},$$

from which it is easy to find ψ , having previously assumed d the radius of the mirror, f the radius of the flame, and μ the refractive index of the glass. It is obviously necessary to assume the value of μ for the least refrangible rays of the spectrum, in order to insure the total reflexion of all the incident light.

The following examples will illustrate the manner of using the formulæ which have now been investigated:

1. Suppose we assume the radius of the mirror to be 20 inches, that the flame is 1.3 inch in diameter, and that the index of refraction of the glass is 1.57, we have first to determine ψ from the formula,

$$45^\circ - \frac{\psi}{4} > \sin^{-1} \frac{1}{\mu} + \sin^{-1} \frac{f}{\mu d}.$$

In this, putting $f = .7$, $d = 20$, and $\mu = 1.57$, we obtain $\psi = 16^\circ 38'$ nearly. Now, since $\frac{180}{11} = 16^\circ 21' 49''$, it follows there must be at least five zones and a central conoid.

Having thus obtained ψ , we have next to find r , a , and b , from the formulæ at (1.)

$$\begin{aligned} r &= \frac{d \sin \frac{\psi}{2}}{2 \sin \left(45^\circ - \frac{\psi}{8} \right) \sin \frac{\psi}{8}} \\ a &= -d \cos \frac{\psi}{2} + r \sin \left(45^\circ - \frac{\psi}{4} \right) \\ b &= -r \sin 45^\circ. \end{aligned}$$

From these it will be found that

$$r = 58.512 \quad a = 18.523 \quad b = -41.375.$$

* This assumption is perfectly safe; for its effect is evidently to make the angle of incidence $C A K$ less than it really is, and consequently the resulting value of ψ will be rather too small.

To compare this result with that given by the formulæ (2), it must be borne in mind that $2m$ in the second set of formulæ is the same as x'' in the first. Now, we have already found, p. 699, that

$$y' - y'' = \tan \frac{\theta + \gamma}{2} (x' - x'')$$

from which, since $y'' = 0$, and x' , x'' , are both negative,

$$x'' = x' + y' \cot \frac{\theta + \gamma}{2}$$

and since

$$x' = d \cos \frac{\psi}{2}, y' = d \sin \frac{\psi}{2} \text{ and}$$

$$\frac{\theta + \gamma}{2} = 45 - \frac{\psi}{8}$$

we obtain
$$2m = d \left\{ \cos \frac{\psi}{2} + \sin \frac{\psi}{2} \cot \left(45 - \frac{\psi}{8} \right) \right\}$$

from which by substituting the value of ψ

$$2m = 22.85362, *$$

and then from the formulæ

$$r = 4m \sqrt{2}, a = 2m \text{ and } b = -4m,$$

we find $r = 64.640$; $a = 22.854$; $b = -45.707$.

It will now be observed that the values of r found by the two formulæ differ by nearly 4.77 inches; but this will not produce a very great aberration of the rays, seeing the arcs of the circles are so small that they will not deviate greatly from each other. To ascertain the amount of the error introduced by using the approximate value for r , we must bear in mind that the circles calculated by the two formulæ have a common tangent at B. For in the osculating circle to the parabola at B,

$$\frac{dy}{dx} = \frac{2m}{y} = \frac{2m}{2m} = \tan 45^\circ,$$

and the tangent to the other circle at the same point by the construction, makes an angle of 45° with the axis; and therefore, since one lies wholly within the other, they will separate from each other most widely at A. We shall, in order to estimate the error introduced by using the formulæ (2,) calculate the difference of their ordinates at A, and also the difference of their inclinations to the axis at that point. For this purpose we have the equation to the circle found by formulæ (2)

$$(x - 2m)^2 + (y + 4m)^2 = r^2,$$

in which substituting for x its value, $d \cos \frac{\psi}{2}$, we obtain $y = 2.86515$.

But the correct value of y at that point is

$$d \sin \frac{\psi}{2} = 2.84634.$$

* It may be proper to remind the reader that this preliminary calculation is only required here in order to compare the formulæ by calculating the value of r for a mirror of exactly the same dimensions in both cases. In applying the second set of formulæ, originally, we might at once assume a value for m , and then the calculation would be much shorter than by the other method.

Therefore the distance of the two arcs, reckoned along y is $\cdot 019$; but since the ordinates are evidently inclined to the normals to the circles at the point A at an angle

$$45 - \frac{\psi}{4} = 40^\circ 45',$$

the true distance of the circles will be $\cdot 019 \sin 40^\circ 54' = \cdot 012$ —a difference perhaps within the limit of the errors of workmanship in such apparatus.

Again, to calculate the aberration of the rays reflected at A, we have from the equation to the circle

$$\frac{dy}{dx} = -\frac{x - 2m}{y + 4m}$$

which should evidently be equal to $\tan \theta$; and substituting the values of x and y , we find $\theta = 41^\circ 17' 7''$. Now, the true value of θ at the point A in the circle depends upon that of $\frac{\psi}{2}$, and we have seen that

$$\theta = 45 - \frac{\psi}{4}, \text{ also } \frac{\psi}{2} = \tan^{-1} \frac{y}{x}.$$

Therefore, substituting the values of x and y , we find $\theta = 40^\circ 52' 56''$, which shows an error in the inclination of the reflecting surface at A amounting to $0^\circ 24'$. But since the error in the direction of the reflected rays is double of this, and the same error affects the opposite reflecting side of the prism, the final error in the direction of the rays will be $1^\circ 36'$, and this will give a *lateral* aberration of $\cdot 56$ inches when the rays are finally returned to the flame.

In this example we have taken a value of μ perhaps rather higher than that of the ordinary flint-glasses for the least refracted rays. We shall, therefore, in the next example assume $\mu = 1.55$.

Suppose the mirror intended for a light of the first order, illuminated by Fresnel's great lamp, with a wick 3.6 inches in diameter, then if the internal radius of the mirror be assumed at 24 inches, and if $\mu = 1.55$ for the extreme red rays, we shall find, as formerly, the limiting value of ψ to be $8^\circ 11' 40'' = 8.2^\circ$ nearly; from which it follows, since $\frac{180^\circ}{8.2^\circ} = 22$

that there must be 11 zones and a central conoid. Hence $\psi = 7^\circ 49' 34''$. From this value of ψ , putting $d = 24$, and $f = 1.8$, it will be found from the formulæ (1)

$$r = 70.624; a = 24.260; b = -49.940.$$

If r , a , and b be calculated by means of the osculating circle to the parabola in the manner already explained, it will be found that

$$r = 72.517; a = 25.639; b = -51.278.$$

From this it appears that the values of r , calculated by the two formulæ, differ by nearly 1.89 inch, or by about $\frac{1}{35}$ th of the whole length of the radius. The difference of the ordinates of the circle at the point A will be found in the same manner as before, to be $\cdot 0027$ inch, from which the perpendicular distance of the arcs is found to be $\cdot 0018$ inch, a quantity quite within the limits of error in constructing such apparatus.

Finally, the error in inclination of the osculating circle to the parabola at the point A is $5' 46''$, from which the lateral aberration of the rays from

the point F will be about 16 inches, a quantity which may be safely neglected with a flame 3.6 inches in diameter. It seems, therefore, from these examples that the approximate formulæ will give sufficiently accurate results in the cases most likely to occur in practice.

It may have already occurred to the reader as a remarkable peculiarity of the totally reflecting mirror, that since the rays at their first incidence and final emergence are perpendicular to the surface of the glass, they suffer no deviation by refraction; and consequently the curvature of the different surfaces is totally independent of the refractive power of the glass. It is otherwise, however, with the determination of the greatest admissible breadth of the zones. Here the index of refraction of the glass enters as an element into the calculation; and the higher the refraction the greater may be the breadth of a zone capable of reflecting all the incident light. Flint glass, from its high refractive power, is therefore more suitable than plate glass for the construction of the totally reflecting mirror; for, owing to their greater breadth a smaller number of zones of the former material will be required to complete a hemisphere, and the expense of construction will accordingly be lessened.

Since this paper was read, it has occurred to me that the totally reflecting mirror will probably have certain properties rendering it preferable to a metallic reflector, which it may be proper to mention here. In a recent application of the holophotal principle to an instrument of very great size, so much heat was reflected from the metallic hemisphere as to cause the ebullition of the oil; an inconvenience which, however, has been obviated mechanically. Now, it has been found that, at moderate angles of incidence, glass reflects much less heat than metal. If this be true also at an incidence of 90° , the totally reflecting mirror, by its superficial reflection, will return much less heat than a metallic hemisphere. Then, of the heat-rays which enter the glass, besides those which are absorbed, it is probable that a considerable portion, owing to their low refrangibility, will escape total reflection, and emerge harmlessly at the back of the mirror.

The investigation of the different formulæ already given, is that by which they were originally obtained. The following are the principal steps of geometrical demonstrations, which are added for those who may prefer them.

1. In fig. 2 join A B, and let A D, F B intersect each other in G. Since the ray F A is reflected at A in the direction A C, perpendicular to F B, the normal A D bisects the angle F A C.

Therefore putting—

$$A F = d, A D = r, F E = a, D E = -b, \text{ and } A F C = \frac{\psi}{2},$$

$$C A D = D A F = \frac{1}{2} (90^\circ - A F C), \text{ or } D A F = 45^\circ - \frac{\psi}{4}.$$

$$\text{Then } G B D + G D B = G A F + A F G; \text{ from which } A D B = \frac{\psi}{4}, \text{ and}$$

$$A B F = A B D - F B D = 45^\circ - \frac{\psi}{8}.$$

$$\text{Now } AB = \frac{AF \sin AFB}{\sin ABF} = \frac{d \sin \frac{\psi}{2}}{\sin \left(45^\circ - \frac{\psi}{8} \right)};$$

$$\text{and } AD = \frac{1}{2} AB \operatorname{cosec} ADB = \frac{AB}{2 \sin ADB};$$

$$\text{Hence } r = \frac{d \sin \frac{\psi}{2}}{2 \sin \left(45^\circ - \frac{\psi}{2} \right) \sin \frac{\psi}{4}}.$$

Also $FE = EC - FC = AD \sin ADE - AF \cos AFC$, and $DE = BD \sin EBD$. From which $a = r \sin \left(45^\circ - \frac{\psi}{4} \right) - d \cos \frac{\psi}{2}$ and $b = -r \sin 45^\circ$.

2. To find the osculating circle at the point B, on the supposition that AB is a parabolic arc, whose focus is F, and BF its principal semi-parameter. Produce BF towards F, until the whole line produced is equal to four times BF; and on it describe a square. About the square describe a circle, which will then be the osculating circle at the point B (see Wallace's Conic Sections, Prop. 1, on *Curvature*;) and putting $FB = 2m$, we shall evidently have the radius of the circle $= 4m\sqrt{2}$. $BE = ED = 4m$; therefore $FE = 2m$. Hence, as before,

$$r = 4m\sqrt{2}; a = 2m; b = -4m.$$

APPENDIX P—No. 1.

Instructions for the Light-keepers of the Northern Light-houses.

1. The lamps shall be kept burning bright and clear every night from sunset to sunrise; and in order that the greatest degree of light may be maintained throughout the night, the wicks must be trimmed every four hours, or oftener if necessary; and the keeper who has the first watch shall take care to turn the oil valves so as to let the oil flow into the burner a sufficient time before lighting.

2. The light-keepers shall keep a regular and constant watch in the light-room throughout the night. The first watch shall begin at sunset. The light-keepers are to take the watches alternately, in such manner that he who has the first watch one night shall have the second watch next night. The length or duration of the watch shall not, in ordinary cases, exceed four hours; but during the period between the months of October and March, both inclusive, the first watch shall change at eight o'clock. The watches shall at all times be so arranged as to have a shift at midnight.

3. At stations where there is only one light-room, the daily duty shall be laid out in two departments, and the light-keepers shall change from one department to the other every Saturday night.

4. FIRST DEPARTMENT.—The light-keeper who has this department shall, immediately after the morning watch, polish or otherwise cleanse the reflectors or refractors till they are brought to a proper state of brilliancy; he shall also thoroughly cleanse the lamps and carefully dust the chandelier. He shall supply the burners with cotton, the lamps with oil, and shall have every thing connected with the apparatus in a state of readiness for lighting in the evening.

5. SECOND DEPARTMENT.—The light-keeper who has this department shall cleanse the glass of the lantern, lamp-glasses, copper and brass work and utensils, the walls, floors, and balcony of the light-room, and the apparatus and machinery therewith connected; together with the tower stairs, passage, doors, and windows, from the light-room to the oil cellar.

6. For the more effectual cleansing of the glass of the lantern, and management of the lamps at the time of lighting, both light-keepers shall be upon watch throughout the first hour of the first watch every night, during the winter period, between the first day of October and the last day of March, when they shall jointly do the duty of the light-room during that hour. These changes to and from the double watch shall be intimated by the keepers in the monthly returns for October and April. The light-keepers must return to the light-house, on all occasions, so as to be in time to attend the double watch at lighting time during the winter months.

7. At those stations where there are two light-rooms, each light-keeper shall perform the entire duty of both departments in that light-room to which he may be especially appointed. But after the first hour of the first watch, the light-keeper who has charge of this watch shall perform the whole duty of trimming and attending the lights of both light-rooms till the expiration of his watch; and, in like manner, his successor on the watch shall perform the whole duty of both light-rooms during his watch.

8. The light-keeper on duty shall on no pretence whatever, during his watch, leave the light-room and balcony, or the passage leading from one light-room to another, at stations where there are two lights. Bells are provided at each light-room to enable the light-keeper on duty to summon the absent light-keeper; and if at any time the light-keeper on duty shall think the presence or assistance of the light-keeper not on duty is necessary, he shall call him by ringing his bell, which should be immediately answered by the return-signal, and the keeper so called should repair to the light-room without delay. In like manner, when the watches come to be changed, the bell shall be rung to call the light-keeper next in turn. After which the light-keeper on duty shall, *at his peril*, remain on guard till he is relieved by the light-keeper in person who has the next watch.

9. Should the bell of the light-keeper, whose turn it is to mount guard, happen to be in an unserviceable state, the other house-bell shall be used, and some of the inmates of that house shall call the light-keeper not on duty so as by all means to avoid leaving the light-room without a constant watch during the night.

10. The principal light-keeper is held responsible for the safety and good order of the stores, utensils and apparatus of what kind soever; and for every thing being put to its proper use, and kept in its proper place. He shall take care that none of the stores or materials are wasted, and shall

observe the strictest economy and the most careful management, yet so as to maintain in every respect the best possible light.

11. The principal light-keeper shall daily serve out the allowance of oil and other stores for the use of the light-room. The oil is to be measured by the assistant, in the sight of the principal light-keeper. The light-keepers are on no account to leave the turning-keys attached to the cranes of the oil cisterns, after drawing oil, but shall remove and deposit them on the tray beside the oil measures.

12. The light-keeper shall keep a daily journal of the quantity of oil expended, the routine of their duty, and state of the weather, embodying any other remarks that may occur. These shall be written in the journal-books, to be kept at each station for the purpose, at the periods of the day when they occur, as they must on no account be trusted to memory. On the first day of each month they shall make up and transmit to the engineer a return, which shall be an accurate copy of the journal for the preceding month.

13. The light-keepers are also required to take notice of any shipwreck which shall happen within the district of the light-house, and to enter an account thereof, according to the prescribed form, in a book furnished to each station for this purpose; and in such account they shall state whether the light was seen by any one on board the shipwrecked vessel and recognized by them, and how long it was seen before the vessel struck. A copy of this entry shall form the shipwrecked return, to be forthwith forwarded to the engineer. When any application is made to the light-keepers for information as to shipwrecks in the neighborhood of the station, or as to the state of the weather, or the management and arrangement of the light-houses, they are to direct the applicants to communicate with the engineer or secretary of the board in Edinburgh.

14. A book, containing a note of the vessels passing each light-house, shall be kept; and an annual schedule, showing the number of vessels in each month, shall be sent to the engineer in the month of January.

15. The monthly and shipwreck returns are to be written by the assistant, and the accompanying letters by the principal light-keeper. The whole shall be carefully compared, and the additions of the various columns tested by both light-keepers, who shall also sign the same as correct, according to the printed form, and the principal keeper shall despatch by post to the engineer as soon as possible. The accounts presented at the light-houses are to be carefully examined and checked by both light-keepers, before being sent to the engineer.

16. For each station there shall be at least one person resident near the light-house, who shall be fully instructed in the whole practice of the light-room duty, and shall come under an agreement to be always ready to take the place of either keeper, in case of sickness or other emergency. This person shall be called the "Occasional Keeper;" and he shall be duly instructed in the duty, and qualified for this trust by a residence in the light-house, and course of training in the whole of the duty during not less than three weeks for the reflecting, and four weeks for the refracting lights. For the purpose of keeping up the practical knowledge of the "Occasional Keeper," he shall be annually called in by the principal light-keeper to do duty for a fortnight in the month of January; and the same shall be stated in the monthly letter. At inaccessible stations, where there are two "Oc-

casional Keepers," they shall each serve a fortnight in January, and shall, as much as possible, be called in alternately to do duty.

17. The principal light-keeper is held responsible for the regularity of the watches throughout the night, for the cleanliness and good order of the reflecting or refracting apparatus, machinery, and utensils, and for the due performance of the whole duty of the light-room or light-rooms, as the case may be, whether performed by him personally, or by the assistant.

18. The principal light-keeper is also held responsible for the good order and condition of the household furniture belonging to the light-house board, as well in his own as in the assistant's house. This duty extends also to the cleanliness of the several apartments, passages, stairs, roofs, water-cisterns, store-rooms, workshops, privies, ash-pits of the dwelling-houses, offices, court, and immediate access to the light-house.

19. The light-keepers shall endeavor to keep in good order and repair the dykes enclosing the light-house grounds, the landing-places and roads leading from thence to the light-house, and the drains therewith connected; together with all other things placed under their charge.

20. When stores of any kind are to be landed for the use of the light-house, the light-keepers shall attend and give their assistance. The principal light-keeper must, upon these occasions, satisfy himself, as far as possible, of the quantity and condition of the stores received, which must be duly entered in the store-book and monthly return-book.

21. The light-keepers are to make a report of the quality of the stores, in the monthly return for March annually, or earlier, should circumstances render this necessary; and this report must proceed upon special trial of the several cisterns of oil and the other stores in detail, both at the time of receiving them and after the experience of the winter months.

22. At all stations where peat-fuel is in use, there must be such a quantity of peats provided, that the stock of the former year shall be a sufficient supply to the end of the current year.

23. Should the supply of any of the light-house stores at any time appear to the principal light-keeper to be getting short, so as thereby to endanger the regular appearance of the light, he shall immediately intimate the same to the engineer; and he must be guided by prudence in reducing the stated number of burners until a supply be received.

24. The light-keepers are prohibited from carrying on any trade or business whatever. They are also prohibited from having any boarders or lodgers in their dwelling-houses, and from keeping dogs at the light-house establishments.

25. The light-keepers are also directed to take care that no smuggled goods are harbored or concealed in any way in or about the light-house premises or grounds.

26. The light-keepers have permission to go from home to draw their salaries, and also to attend church. The assistant light-keeper, on all occasions of leave of absence, must consult the principal light-keeper as to the proper time for such leave, and obtain his consent; in like manner, the principal light-keeper shall duly intimate his intention of going from home to the assistant light-keeper; it being expressly ordered that only one light-keeper shall be absent from the light-house at one and the same time.

27. While the principal light-keeper is absent, or is incapacitated for duty by sickness, the full charge of the light-room duty and of the premises shall devolve upon the assistant, who shall in that case have access to the

keys of the light-room stores, and be held responsible in all respects as the principal light-keeper; and in case of the incapacity of either light-keeper the assistance of the "Occasional Light-keeper" shall be immediately called in, and notice of the same given to the engineer. Notice to be taken of any such occurrences in the monthly return, or by special letter to the engineer, should circumstances render this necessary.

28. The light-keepers are required to be sober and industrious, cleanly in their persons and linens, and orderly in their families. They must conduct themselves with civility to strangers, by showing the premises at such hours as do not interfere with the proper duties of their office; it being expressly understood that strangers shall not be admitted into the light-room after sunset. But no money or other gratuity shall be taken from strangers on any pretence whatever.

29. Frequent intimations having been made in the newspapers as to pleasure excursions to islands on which light-house establishments are placed, and representations having been made of the danger of injury to the lighting apparatus from parties crowding the light-room, it is hereby directed that, when more than twelve persons visit a station, the light-room and lighting apparatus shall not be open to inspection; and it is further directed, that not more than three strangers shall have access to any light-room at one and the same time. The light-keepers must not, on any pretext, admit persons in a state of intoxication. The light-house establishments are not to be open to the public on Sunday. No stranger visiting a light-room shall be permitted to handle any part of the apparatus, or make drawings, or to take any dimensions, unless he shall produce a written authority for so doing from an officer of the board.

30. The light-keepers are to appear in their uniform-dress when any of the commissioners or principal officers visit a station, and also on Sunday; on which day, at noon, the weather permitting, the light-house flag shall be hoisted by the assistant light-keeper, or in his absence by the principal light-keeper, when it shall remain displayed until sunset.

31. In collecting the accounts due to tradesmen and others near the station at the half-yearly terms, the principal keeper must send the exact address of the parties to whom money is to be paid, so that an order for payment may reach them directly from the office. There are also issued two papers, one of which is called "List of accounts delivered," and the other "Account of sums claimed." The first paper must contain a list of the small sums mentioned below, and his own customary claims. In the second paper the keeper will enter his own claims in detail, the amount of which will also be entered in the first; and he will, at the same time, give a copy of the form to the assistant for the entry of his claims. The principal keeper will send direct to the engineer all other accounts incurred for work done at the light-house, *as soon as the work is completed*, without waiting till the end of the half-year. The half-yearly list will thus merely include any small accounts, such as those for washing, carriage of letters and parcels, rents of seats in church, shoeing the horse, and other small customary charges from the keepers.

32. In the event of any neglect occurring in the performance of any part of the duties required from a light-keeper, the offending party shall, *jointly* with the other light-keeper or light-keepers at the station, send *immediate* notice of the circumstance to the engineer; and, in the event of one party refusing or neglecting to concur in giving this intimation, the others

(whether principals or assistants) shall proceed to give the notice in their own names.

33. The breach of any of the foregoing rules and instructions shall subject the light-keepers to dismissal, or to such other punishment as the nature of the offence may require.

34. It is recommended that the principal light-keeper or other principal officer at the respective light-houses for the time being, shall every Sunday perform the service pointed out for the inmates, by reading a portion of the Scriptures, and any other religious book furnished by the board, and the prayer composed for their use by the Rev. Dr. Brunton, one of the ministers of Edinburgh, or other prayers in any work furnished by the board. For this purpose, the principal light-keeper shall invite the families to assemble at noon in the visiting officers' room.

35. The light-keepers are to observe that the above general regulations are without prejudice to any more special instructions which may be made applicable to any particular light-house, or to such orders as may from time to time be issued by the engineer.

36. As the commissioners have no power to make provisions for the widows and children of persons in their service, they directed, by minute of February, 1839, that in lieu thereof, the sum of £3 per annum be added to each light-keepers' salary, to be retained, and applied towards effecting an insurance on his life, under the following regulations, which are here repeated for the information and guidance of the light-keepers:—

1. That the sum retained for insurance shall in no event be payable to or assignable by any light-keeper, or attachable by his creditors.

2. That the addition made to the light-keepers' salaries shall be employed in paying an annual premium on a policy of insurance on their respective lives, for such a sum as can be obtained for such premium, in reference to the age of the party insured; the policy for such insurance to be taken in the name of the Commissioners, and the sums contained in them to be payable to the Commissioners after the death of the light-keeper.

3. That it shall be competent to every light-keeper, at any time during his life, by any writing under his hand, either in the form of a letter to the Secretary, or otherwise, to direct in what manner he would wish the sum arising from his policy of insurance, at his death, to be applied for the benefit of his wife and family; but it is to be understood that the board consider it inexpedient that in any case they should retain the sum coming into their hands for the behoof of such widow or family; and that in the event of no written directions being left, the board will apply such sums for behoof of the widow or family, one or both, at their discretion, in such way as they may think most beneficial, without having regard to the manner in which such sums might fall to be divided at common law.

4. That in the event of no such directions for behoof of the widow and family being left by the light-keeper, the policies, and sums arising from them shall be held by the board exclusive of the creditors or other assignees of the deceased light-keeper, the object being to provide a fund for the widow and family, where such are left.

5. That in the event of any light-keeper being at any time dismissed from, or leaving the service of the board, he is to have no claim on the policy, nor for the annual premiums paid, nor for its value—the same, in that case, being entirely at the disposal of the board; with power to them, nevertheless, if they shall see cause, to give up the policy to the party dis-

missed or leaving the service, or to his family, or to give its value, or otherwise to dispose of it.

6. That in the event of any light-keeper dying, and leaving no wife and family, the board will still apply the sums coming into their hands in terms of any written directions he may leave; but failing such, and on his dying intestate, the board will leave the insurance office to settle with his next of kin according to the usual forms of law.

7. That from the salary of every light-keeper hereafter entering the service, a sum of £3 shall be retained annually to effect an insurance on his life, subject to the above conditions.

37. These instructions are to be read in the light-room by the principal light-keeper, in the hearing of his assistant, on the term days, before drawing his salary; and notice of such reading taken in the monthly returns.

ALAN STEVENSON, *Engineer*.

OFFICE OF THE BOARD OF NORTHERN LIGHT-HOUSES,
Edinburgh, December 12, 1849.

EDINBURGH, *December 12, 1849.*

The commissioners having considered the preceding rules and instructions, approve of the same; direct them to be substituted for those now in use; appoint them to be signed by the engineer, and copies of them and of this minute to be issued to the present light-keepers; direct a copy to be delivered in future to each light-keeper at the time of his appointment, that they may understand that they are placed under the department and superintendence of the engineer, who is held responsible for the strict observance of the rules and instructions, and for their general good conduct; that the engineer has power, in case of neglect or disobedience, instantly to suspend and remove any of the light-keepers, and to report the case to the commissioners, by whom it will be considered, and the offending party subjected to dismissal, or such other punishment as the offence may merit. In case of a punishment less than dismissal, that circumstance, as well as the general conduct of the light-keeper, will always be taken into consideration when any application may be made for the superannuated allowance.

Extracted from the minutes by

ALEX. CUNINGHAM, *Secretary*.

P—No. 2.

Instructions to the keepers of light-houses within the United States.

1. You are to light the lamps every evening at sun-setting, and keep them continually burning bright and clear till sun-rising.

2. You are to be careful that the lamps, reflectors, and lanterns, are constantly kept clean, and in order; and particularly to be careful that no lamps, wood, or candles, be left burning anywhere so as to endanger fire.

3. In order to maintain the greatest degree of light during the night, the

wicks are to be trimmed every four hours, taking care that they are exactly even on the top.

4. You are to keep an exact account of the quantity of oil received from time to time; the number of gallons, quarts, gills, &c., consumed each night; and deliver a copy of the same to the superintendent every three months, ending 31st March, 30th June, 30th September, and 31st December, in each year; with an account of the quantity on hand at the time.

5. You are not to sell, or permit to be sold, any spirituous liquors on the premises of the United States; but will treat with civility and attention, such strangers as may visit the light-house under your charge, and as may conduct themselves in an orderly manner.

6. Should the superintendent omit to supply the quantity of oil, wicks, tube-glasses, or other articles necessary to keep the lights in continual operation, you will give him timely notice thereof, that he may forward the requisite supplies.

7. You will not absent yourself from the light-house, at any time, without first obtaining the consent of the superintendent, unless the occasion be so sudden and urgent as not to admit of an application to that officer; in which case, by leaving a suitable substitute, you may be absent for the space of twenty-four hours.

8. All your communications intended for this office, must be transmitted through the superintendent, through whom the proper answer will be returned.

_____,
Fifth Auditor and acting commissioner of revenue.

TREASURY DEPARTMENT,
Fifth Auditor's Office.

Instructions to the keepers of the floating lights of the United States.

1. You are to light the lamps every evening at sunsetting, and keep them continually burning, bright and clear, till sunrise.

2. You are to be careful that the lamps and lanterns are constantly kept clean, and in order; and particularly to be careful that no lamps, wood, or candles be left burning anywhere, so as to endanger fire.

3. In order to maintain the greatest degree of light during the night, the wicks are to be trimmed every four hours, taking care that they are exactly even on the top.

4. You are to keep an exact account of the quantity of oil received from time to time; the number of gallons, quarts, gills, &c., consumed during each quarter; and deliver a copy of the same to the superintendent at the close of the respective quarters, on the 31st March, 30th June, 30th September, and 31st December, in each year; with an account of the quantity on hand at the time.

5. You are not to sell, or permit to be sold, any spirituous liquors on board your vessel; but will treat with civility and attention such strangers as may visit the light-vessel under your charge, and as may conduct themselves in an orderly manner.

6. You will keep a daily journal, (subject to the inspection of the superintendent,) in which you will note down the time you or any of the crew

may be absent from the vessel, and the cause of such absence; the state of the weather; the number and kind of vessels which may have passed the floating light, together with any accidents that may have occurred to vessels by getting on shore.

7. You will cause the vessel's decks to be washed and cleaned at least once a day, and will occasionally cause water to be thrown into, and pumped out of the hold of the vessel, in order to cleanse and purify it; and with the view to preserve the vessel from decay, and promote the health of the crew, you will cause the hold, during the hot months, to be well and constantly aired by means of wind-sails.

8. No negro or mulatto, whether free or slave, is to be employed on board the floating light under your command, with the exception of the cook, who may be a person of color.

9. You will cause the ballast to be taken up, cleaned, and replaced, every six months.

10. You will not absent yourself from the light vessel, at any time, without first obtaining the consent of the superintendent, unless the occasion be so sudden and urgent as not to admit of an application to that officer; in which case, by leaving a suitable substitute, you may be absent for the space of twenty-four hours.

11. All your communications intended for this office must be transmitted through the superintendent, through whom the proper answers will be returned.

Fifth Auditor and Acting Commissioner of the Revenue.

TREASURY DEPARTMENT,

Fifth Auditor's Office, July 10, 1835.

BY THE CORPORATION OF TRINITY-HOUSE OF DEPTFORD-STROND.

Instructions to the masters and mates of their light-vessels.

I. You are to light the lamps every evening at sunsetting, and keep them constantly burning bright and clear till sunrising.

II. In order to maintain the greatest degree of light, the wicks are to be trimmed every three hours, and especial care taken that their tops are cut exactly even.

III. You are to be careful that the lamps and reflectors are cleaned and polished every morning, using for that purpose the polishing powder and leathers provided by the corporation, and no other means: the glazing of the lantern is also to be constantly kept, both internally and externally, in the cleanest possible condition; and you are further required constantly to preserve cleanliness throughout the vessel, and also in your own person, and in the persons of the crew.

IV. You are to take especial care that neither lamps, candles, coals, or any other article, be left burning anywhere so as to endanger fire.

V. You are to take care that the oil is always emptied into the cisterns as soon as received on board, and that none of the oil, stores, goods, or materials, whether appertaining to the light or to the vessel, be wasted,

embezzled, or stolen, and that all economy and good management, consistently with the maintenance of a perfectly good light, be in every respect, and at all times, observed.

VI. You are forthwith to take an inventory of all anchors, cables, sails, and all other stores, materials, and furniture in the light-vessel whereof you are appointed master; you are also, at the termination of each half-year, to make out a similar inventory, in order to its transmission through the proper channel, to this house, that the corporation may be acquainted with those articles which have been expended.

VII. You are to keep an exact account of the quantity of oil and lighting stores received on board from time to time, and enter the nightly consumption of the former, in the form provided for that purpose, and send the same with a statement of the quantity remaining on board, to the agent, at the end of every month; you are also, at the end of each quarter, to furnish an account on the form provided, of all stores expended, with the quantities then remaining.

VIII. You are, at the end of every quarter, to make out an account of your expenses for wages and provisions, at the stated allowances for yourself and crew, and send the same to the agent, who will pay you the amount thereof when approved.

IX. You are to take especial care that neither you nor any of the crew be concerned, yourselves, nor aiding nor assisting others, in running any goods out of any ship, vessel, or boat, to the prejudice of her Majesty's revenue; neither are you to suffer any kind of goods to be brought on board the light-vessel from any ships or vessels, except those in distress, and in that case you are to take care that there be no embezzlement or damage, or practices whatever, that may prejudice either the owners or the crown.

X. You are to remain on board the vessel, at her station, for one calendar month, at the end of which you are to be relieved by the mate, who is to take charge during the succeeding calendar month, so that either you or the mate are to remain on board the light-vessel, at her station, every alternate month throughout the year; and the reliefs, both of yourself and of the crew, are regulated as follows, viz:

On the first day of each month, (wind and weather permitting) the master or mate, one lamplighter, and two seamen, (carpenter always reckoned as one) are to be relieved and taken on shore, and seven of the crew, consisting of the master or mate, two lamplighters, and four seamen, are to remain constantly on board.

XI. During the periods of your turn to remain on shore, you are not to absent yourself, nor suffer the seamen whose turn it is to be on shore, to be absent from the neighborhood of without special permission from the corporation, but are always to remain ready to render your services in navigating the tender, or in executing such buoy service as shall attach to the district; you are also to be watchful to proceed to the light-vessel with such seamen at the appointed periods of relief, and also at other times, to afford every assistance to the light-vessel that may be requisite, and particularly in the event of any accident, or of the light-vessel breaking from her moorings, you and the seamen on shore, are as early as possible to join the vessel, and not quit her again until she shall be safely brought back, and replaced at her station; and this regulation is to apply in like manner to the mate during the period of his turn on shore.

XII. You are, in unsettled or tempestuous weather, to cause the number of the watch to be increased, frequently yourself going upon deck, and vigilantly superintending the said increased watch, and thus ascertain that strict attention is given to the safe riding of the light-vessel at her moorings.

XIII. On such occasions, you are to cause constant attention to be given to the deep-sea lead, which is to be kept overboard, and to such further proceedings, either by taking bearings, or otherwise, as shall best enable you, at all times, to determine whether the vessel retains her proper situation.

XIV. In those cases in which the light-vessel is moored with a span and bridle, the ring of the ground-chain is, upon the lowest ebb of every spring tide, to be hove up to the bows of the light-vessel. And in those cases in which the moorings consist of a single mushroom and chain, the vessel is at the like times to be hove short upon the mushroom. If, from the state of the weather, it may be found impracticable to perform this service upon the lowest tide, it shall be done upon the first succeeding low water upon which it may be possible to effect this duty, and in either case, its execution shall be noted in the log-book, and if not done upon the first-named occasion, the reason of its non-performance.

XV. It being of essential importance that in cases in which the vessel may, by parting her moorings, or other unlooked-for circumstance, be forced from the station, that she should be brought up by her anchor as soon thereafter as shall be consistent with the safety of the vessel, you are to observe that, in tempestuous weather, the bower anchor be in all respects ready for letting go, that a strict and sufficient watch on deck be maintained, and attention given to the use of the deep-sea lead, as directed in paragraph No. 13 of these instructions; by a due regard to which precaution it is considered a vessel can drive but a very short distance before she may be brought up by her anchor; and any neglect herein will subject the officer in charge at the time to the severest displeasure of the board. And it is further strictly enjoined upon that officer to take care that a watch of at least two persons, is constantly kept upon the deck of the vessel by day and by night. And in addition hereto, you are to observe that the sails of the vessel are to be kept bent at all times between the 1st of October and the 1st of April, and also, upon all occasions of tempestuous weather, in other parts of the year.

XVI. In the event of the vessel parting from her moorings, you are immediately to extinguish the lights in the night, and lower the ball in the day, and not again exhibit the lights or show the ball until the vessel is replaced at her station.

XVII. You are to keep a journal in duplicate, upon the form provided in books for this purpose, of all occurrences and observations, and to be particular in describing all circumstances attending them, especially the precise time at which the lamps are trimmed during the night, the length of time which intervenes between the lowering of the lantern and again hoisting the same after the lamps are trimmed; also the times at which it may be necessary to increase the watch upon deck, stating the period when such additional watch comes on duty, and how long continued.

XVIII. The direction and strength of wind and the state of the weather are to be noted in the log book, at 3 a. m., 9 a. m., 3 p. m., 9 p. m., and such other times as may be required. The direction of the wind is to be

given by compass, and its strength denoted by a number less than 14; 13 being supposed to represent a violent hurricane, and 1 the lightest breeze.

XIX. Each time of high water, and each time of low water, the rise of tide (perpendicularly), and the times of changes in the direction of the stream, are to be registered as often and as accurately as may be practicable.

XX. Time for the several observations may be obtained by watches frequently set by the sun, when on the meridian, or when rising or setting. This will, of course, be apparent time: and, in the register, it should be noted whether apparent or the mean time is used.

XXI. The officer in charge is once, at least, on every Sunday, to assemble the crew, with the exception of the watch upon deck, either in his own cabin or other convenient place, and there read to them the church service for the day throughout, and also a sermon or homily from the volume provided by the corporation for this purpose.

BY THE CORPORATION OF TRINITY-HOUSE OF DEPTFORD-STROND.

Instructions to their light-keepers.

I. You are to light the lamps every evening at sunsetting, and keep them constantly burning bright and clear, till sunrising.

II. In order to insure the perfect fulfilment of the foregoing article, a perpetual watch is to be maintained throughout the night;—and, in this respect, the principal is to take equal duty with the assistant keeper; he whose watch is about to end, is to trim the lamps and leave them burning, in perfect order, before he quits the lantern and calls the succeeding watch; and he who has the watch at sunrise, is then to extinguish the lamps, and commence all necessary preparations for the exhibition of the light at the ensuing sunset.

III. In order to maintain the greatest degree of light, the wicks are to be trimmed every three hours, and especial care taken that their tops are cut exactly even.

IV. No bed, sofa, or other article on which to recline can be permitted either in the lantern or in the apartment under the lantern, known as the watch room.

V. You are to be careful that the lamps and reflectors, or other lighting apparatus, are cleaned and polished every morning, using for that purpose, the polishing powder and leathers provided by the corporation, and no other means; the glazing of the lantern is also to be constantly kept, both internally and externally, in the cleanest possible condition.

VI. You are to take especial care that neither lamps, candles, coals, or any other article, be left burning any where so as to endanger fire.

VII. You are to see that none of the oil, stores, goods, or materials be wasted, embezzled, or stolen, and that all economy and good management, consistently with the maintenance of a perfectly good light, be in every respect, and at all times observed.

VIII. If any of the lamps, reflectors, or windows are broken, or other damage be done to the light-house, through carelessness or negligence of

the light-keepers, the repair thereof is to be paid for by the person through whose carelessness or negligence the damage occurred.

IX. You are strictly forbidden from causing any out-buildings to be erected, or any alteration of the light-house, premises, or fences to be made, without having first obtained the sanction of the board.

X. The principal light-keeper is charged with the custody of the oil and stores of every description; he is therefore to keep an exact account of the quantities thereof received from time to time, and of the deliveries for the necessary purposes of the establishment,—also an accurate account of the nightly consumption of oil, on the forms provided for that purpose, and to deliver the same, together with the other accounts for which forms are furnished, to the agent at the regulated periods for transmission to this house.

XI. The principal light-keeper is also to keep a journal of all occurrences and observations, and to be particular in describing all circumstances attending them, and to communicate the same on the form provided for that purpose, once a quarter, or oftener, if necessary.

XII. The light-keepers are to exercise a proper discretion in the admission of visitors to view the establishment, conducting themselves with civility to strangers and other persons upon all occasions, and observing that no person is, on any account, to be permitted to inspect the interior of the lantern unattended by one of the light-keepers, and they are held responsible that no damage is thereby occasioned to the lighting apparatus, or disfigurement to any part of the premises.

XIII. The keepers are to attend a place of worship upon each Sunday in turn, and where this rule shall, by reason of distance, be incompatible with the performance of the light-house service, the principal light-keeper shall, at least once in every Sunday, assemble his own family and his assistants and their families, in his own dwelling or other convenient place, and there read to them throughout, the church service for the day; also a sermon or homily from the volume provided by the corporation for this purpose.

XIV. The light-keepers, both principal and assistants, are cautioned that their retention or promotion in the service depends upon their strict adherence to the rules laid down for their guidance; and also on the constant habit of cleanliness and good order in their own persons, and the preservation thereof in every part of the light-house, lantern, and other premises; and they are enjoined to the invariable exercise of temperance and morality in all their habits and proceedings, so that by their example they may enforce, as far as lies in their power, the observance of the same laudable conduct by their wives and families.

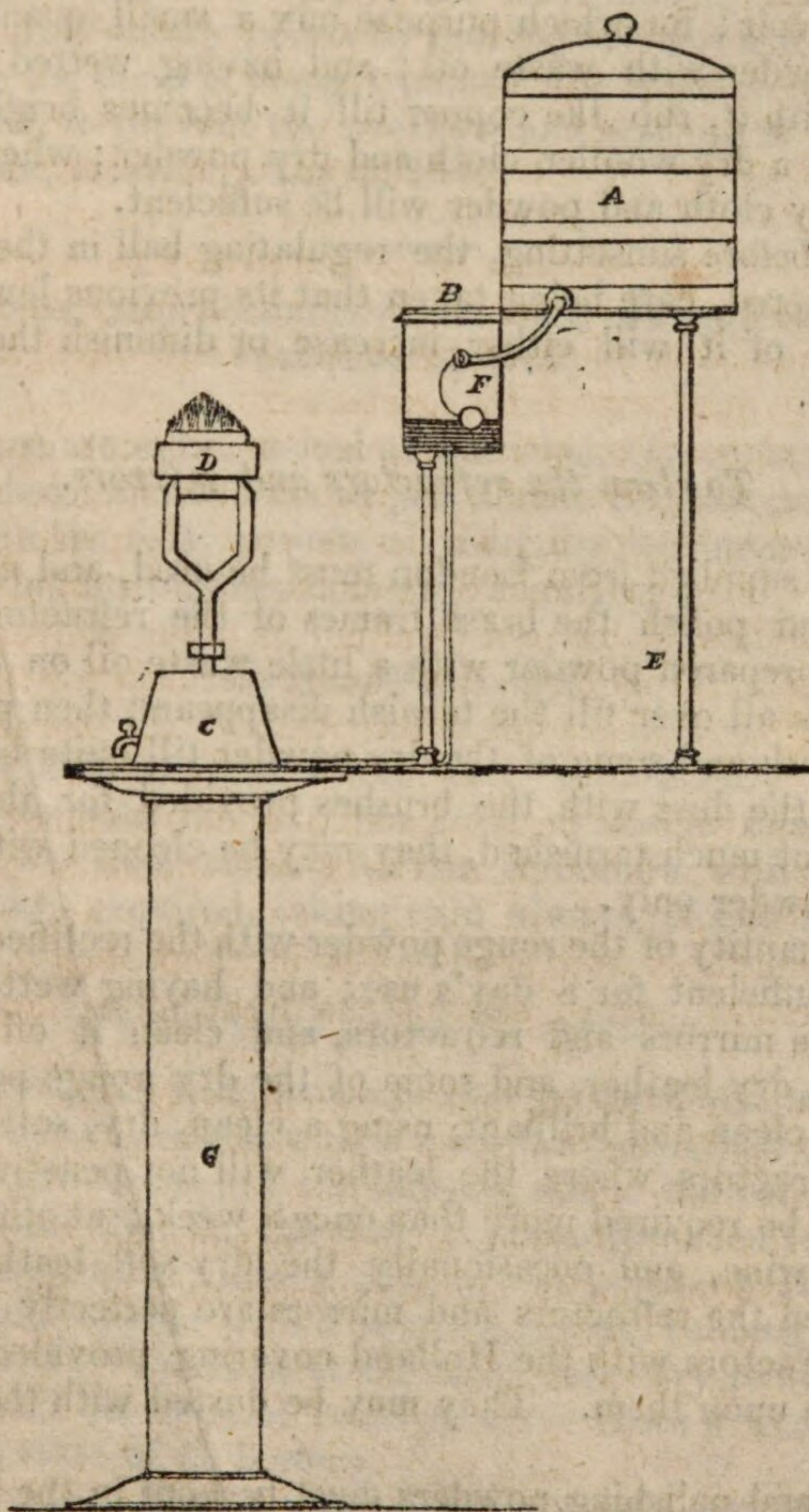
XV. The principal light-keeper is held responsible for the execution of the duties of the establishment, and the observance of the foregoing regulations.

APPENDIX Q—No. 1.

ENGLISH LIGHT-HOUSES.

DIRECTIONS TO THE LIGHT-KEEPERS FOR THE MANAGEMENT OF THE DIOPTRIC
LIGHT AND HYDRAULIC LAMP.

The light is to be extinguished at sunrising, and the flow of oil stopped by raising the regulating balance ball of the supplying cistern B, and the curtains are then to be put up around the lantern; as soon after which as practicable, the light-keeper will commence the daily process of trimming the lamp, and cleaning the refractors and mirrors, observing strictly the following directions :



- A. Reservoir.
- B. Supplying cistern with regulating ball.
- C. Chamber for overflow.
- D. Burner.

- E. Frame of lamp.
- F. Regulating ball cock.
- G. Supporting pillar of lamp.

To trim the hydraulic lamp.

The flow of the oil having been previously stopped when the light was extinguished, as above directed, the reservoir A may be filled, observing exactly the quantity of oil required, as it will give the consumption of the previous night. Cleanse the burner thoroughly in every part, observe that all the union joints are secure, and put in fresh cotton wicks, if required, taking care always to cut them quite even at the top; the oil in the chamber for overflow C may be drawn off at any time, and put into the reservoir A for the following evening, or used in the house lamps.

When the internal parts of the lamp and cisterns require cleansing, the burner and the union joints must be unscrewed; the whole may then be thoroughly cleaned by means of the elastic brushes provided for that purpose. This will probably be required about once in six months.

The lamp being ready for lighting, then clean the outsides of the copper cistern and reservoir; for which purpose mix a small quantity of the prepared Tripoli powder with waste oil; and having wetted a piece of the woollen cloth with it, rub the copper till it becomes bright; after which clean it off with a dry woollen cloth and dry powder; when it is not much tarnished, the dry cloth and powder will be sufficient.

Half an hour before sunsetting, the regulating ball in the supplying cistern must be lowered, care being taken that its previous level be preserved, as any alteration of it will either increase or diminish the proper flow of oil to the burner.

To clean the refractors and mirrors.

The materials supplied from London must be used, and *no others*.

First, clean and polish the brass frames of the refractors; mix a small quantity of the prepared powder with a little waste oil on a woollen cloth, and rub the brass all over till the tarnish disappears; then polish it off with a dry woollen cloth and some of the dry powder till quite bright and clean, and take off all the dust with the brushes provided for that purpose. If the frames are not much tarnished, they may be cleaned with a dry woollen cloth and dry powder only.

Mix a small quantity of the rouge powder with the rectified spirits of wine, not more than sufficient for a day's use; and having wetted a soft sponge with it, wash the mirrors and refractors, and clean it off before it dries with a fine, soft, dry leather, and some of the dry rouge powder, until the whole are quite clean and brilliant, using a clean, dry, soft brush in the recesses of the refractors where the leather will not penetrate. The rouge powder will not be required more than once a week; at other times the rectified spirits of wine, and occasionally the dry soft leather only, will be sufficient. When the refractors and mirrors are perfectly clean, cover the fronts of the refractors with the Holland covering provided to prevent the effect of the sun upon them. They may be dusted with the feather brushes at any time.

The leathers and polishing powders must be kept in the store cases, free from dust, taking care that no grit or hard substance adheres to them to scratch or injure the polish of the refractors or mirrors, and no leather which has been washed or wetted with water must on any account be made use of for them.

When all are completed ready for lighting, the lantern floor and platform must be cleaned with water where requisite; care being taken that no dust is allowed to settle on the refractors or mirrors after they have been polished. If the roof, uprights, or other parts of the lantern require washing, it should be done early in the day before the refractors are cleaned, that the whole may be thoroughly dry before the evening.

During the winter season a fire must be maintained in the stove, at the discretion of the principal light-keeper, sufficient to keep the oil in the lamp in a liquid state; but the temperature of the lantern should not be raised above the external air more than is absolutely necessary for that purpose.

Preparatory to lighting the lamp at sunset, the curtains are to be taken down and put away; in cold weather the glass cylinder should be warmed before it is placed on the lamp, and at all times the flame must be increased very gradually; the best height is *two inches and a quarter*, and not exceeding *two inches and a half*, and it should be frequently attended to and kept free from smoky points by moving the throttle valve of the iron damper. While the lamp is being trimmed, the regulating ball should be raised, if required, to prevent the overflow and wasting of the oil.

TRINITY HOUSE, LONDON, May 4, 1841.

DIRECTIONS TO THE LIGHT-KEEPERS FOR THE MANAGEMENT OF THE REFLECTING LIGHTS.

When the lamps are extinguished at sunrise, the curtains are to be put up round the lantern, and as soon as practicable afterwards the light-keepers will commence the daily process of trimming the lamps and cleaning the reflectors, observing strictly the following directions:

To trim the lamps.

Cleanse them thoroughly in every part, occasionally rinsing out the reservoirs and tubes with hot oil; the glass cylinders must be made perfectly clean and free from stains; fill the reservoirs with oil, and put in fresh cotton wicks if required, taking care always to cut them quite even at the top.

To clean and polish the reflectors.

The materials supplied from London must be used, and *no others*.

Remove the reflector one at a time from the frame, and carry them carefully into the room next below the lantern, and if the back or copper side be tarnished, place them on the table or stand provided for that purpose, with that side uppermost; mix a little of the prepared Tripoli powder in some waste oil, and apply it with a woollen rubber, rubbing smartly till the tarnish is removed; then clean it off with some dry powder and another rubber. This will be required twice or three times a week, according to the weather and state of the lantern.

The reflector must then be placed in the stand, with the face or silver side upwards, and polished with the utmost care, as upon this the brilliancy and efficiency of the light materially depend: having taken off the dust or burnt particles of cotton wick with a reflector cloth, moisten a small quantity of the rouge powder with the rectified spirits of wine, not more than

sufficient for a day's use, and apply it with a soft leather to the silver, rubbing it all over in right lines up and down with its apparent grain, and before it is dry polish it off with a dry leather and a little dry rouge powder, rubbing it briskly till it becomes brilliant and perfectly free from tarnish or stains. This will probably be required about once in a week; at other times, when the silver is not much discolored, it will be sufficient to apply a little dry rouge powder in a soft bag lightly, breathing on it at the same time, and then to polish it off with a clean dry leather.

The leathers and polishing powders are to be kept in the store cases free from damp or dust; in using the leathers great care must be taken to fold them smooth, without crease or uneven surface, and that no grit or hard substance adheres to them to scratch or injure the surface of the silver; and no leather which has been washed or wetted with water must, on any account, be made use of for the reflectors.

When all are completed ready for lighting, the lantern floor and platform must be cleaned with water where requisite, care being taken that no dust is allowed to settle on the reflectors after they are polished. If the roof, uprights, or other parts of the lantern require washing, it should be done early in the day before the reflectors are cleaned, that the whole may be thoroughly dry before evening.

During the winter season the stove must be lighted at the discretion of the principal keeper, and sufficient fire maintained to keep the oil of the lamps in a liquid state, but the temperature of the lantern should not be raised above the external air more than is absolutely necessary for that purpose.

Preparatory to lighting at sunset the curtains are to be taken down and put away. In cold weather the glass cylinders should be warmed before they are placed on the lamps, and at all times the flame must be increased *very gradually*. The best height for the flame is *one inch and a quarter*, and not exceeding *one inch and a half*, and it should be frequently attended to, and kept free from smoky points.

TRINITY HOUSE, *London, May 4, 1841.*

DIRECTIONS TO THE LIGHT-KEEPERS FOR THE MANAGEMENT OF THE DIOPTRIC LIGHT AND PNEUMATIC LAMP.

The light is to be extinguished at sunrising, and the flow of oil stopped by closing the cock E, which has a circular handle. The curtains are then to be put up round the lantern, as soon after which as practicable the light-keepers will commence the daily process of trimming the lamp and cleaning the refractors and mirrors, observing strictly the following directions:

To trim the pneumatic lamp.

The flow of oil having been previously stopped when the light was extinguished, as above directed, the remaining oil must be drawn off from the air-chamber D. Take off the reservoir A, and fill the supplying cistern C, pouring the oil through the tube and cock F, which may be known by its having the common straight handle special care being taken that cock E is shut. When the cistern C is full shut the cock F, fill the reser-

voir A and put it in its place, with the valve over the tube and cock E ; and keep the cock shut during the daytime, that the oil may not overflow the burner and be expended unnecessarily ; cleanse the burner thoroughly in every part, and observe that all the union joints are secure ; put in fresh cotton wicks if required, taking care always to cut them quite even at the top. The oil in the chamber for overflow B may be drawn off at any time and put into the supplying cistern C for the following evening, or used in the house lamps.

When the internal parts of the lamp require cleansing, the burner and the union screw joints (Nos. 1, 2, and 3) must be removed ; the whole of the inside may then be thoroughly cleaned by means of the elastic brushes provided for that purpose. This will probably be required about once in six months.

Half an hour before sunsetting the cock E must be opened ; the oil from the reservoir A will then pass down the tube into the air-chamber D, and force the oil from the supplying cistern to the burner, continuing to do so until the oil is exhausted, and the air-chamber D is filled with oil from the reservoir A.

To clean the refractors and mirrors.

The materials supplied from London must be used, and *no others*.

First clean and polish the brass frames of the refractors. Mix a small quantity of the prepared powder with a little waste oil on a woollen cloth, and rub the brass all over till the tarnish disappears ; then polish it off with a dry woollen cloth and some of the dry powder, till quite bright and clean, and take off all the dust with the brushes provided for that purpose. If the frames are not much tarnished, they may be cleaned with the dry woollen cloth and dry powder only.

Mix a small quantity of the rouge powder with the rectified spirits of wine, not more than sufficient for a day's use, and having wetted a soft sponge with it, wash the mirrors and refractors ; and clean it off before it dries with a soft dry leather and some of the dry rouge powder, until the whole are quite clean and brilliant, using a clean, dry, soft brush in the recesses of the refractors, where the leather will not penetrate. The rouge powder will not be required more than once a week ; at other times the rectified spirits of wine, and occasionally the dry soft leather only, will be sufficient. When the refractors and mirrors are perfectly clean, cover the fronts of the refractors with the Holland covering provided to prevent the effect of the sun upon them. They may be dusted with the feather brushes at any time.

The leathers and polishing powders must be kept in the store cases free from dust, taking care that no grit or hard substance adheres to them to scratch or injure the polish of the refractors or mirrors ; and no leather which has been washed or wetted with water must on any account be made use of for them.

When all are completed ready for lighting, the lantern floor and platform must be cleaned with water where requisite, care being taken that no dust is allowed to settle on the refractors or mirrors after they have been polished. If the roof, uprights, or other parts of the lantern require washing, it should be done early in the day, before the refractors are cleaned, that the whole may be thoroughly dry before the evening.

During the winter season a fire must be maintained in the stove, at the discretion of the principal light-keeper, sufficient to keep the oil in the lamp in a liquid state; but the temperature of the lantern should not be raised above the external air more than is absolutely necessary for that purpose.

Preparatory to lighting the lamp at sunset, the curtains are to be taken down and put away. In cold weather the glass cylinder should be warmed before it is placed on the lamp; and at all times the flame must be increased very gradually. The best height is *two inches and a quarter*, and not exceeding *two inches and a half*, and it should be frequently attended to and kept free from smoky points, by moving the throttle valve of the iron damper. While the lamp is being trimmed, the cock E with the circular handles should be closed or nearly so, if required, to prevent the overflow and wasting of the oil.

TRINITY HOUSE, *London, May 4, 1841.*

NOTICE TO MARINERS.

TRINITY-HOUSE, LONDON,
January 6, 1852.

Notice is hereby given, that this corporation having issued directions to the masters and mates of their several light-vessels to the following effect, viz :

In the event of any light-vessel being driven from her station, the master or mate, whichever be in charge, is carefully to consider whether she has driven to such a distance, or in such a direction, as to make it dangerous to shipping to continue to show her lights; and if the distance or direction be not such as to endanger the safety of vessels running on their course, the *lights and balls* are to be continued in the usual manner.

But should the light-vessel have driven so as to be of no use as a guide to shipping, the *usual lights and balls* are, in that case, to be *discontinued*, and *two red lights substituted*, one at the end of the davit forward, the other on a stanchion beside the ensign staff; and a *red flare light* shown every quarter of an hour during the night.

And further, when vessels are observed from a light-vessel to be in distress, or to require assistance :

If in the day time, two guns are to be fired on board such light-vessel, each at an interval of five minutes, and repeated every half hour until assistance be observed approaching.

If in the night time, two guns are to be fired on board such light-vessel, at similar intervals, each followed by a white rocket thrown in the direction of the vessel in distress, and these signals are to be continued until the required assistance has been rendered.

Masters of vessels, pilots, and other persons are earnestly requested to take such necessary note of these regulations as may be useful both for the avoidance of danger to themselves, and for aiding their endeavors to render assistance to others.

By order,

J. HERBERT, Sec.

NOTICE TO MARINERS.

MARINE SURVEYOR'S OFFICE,
LIVERPOOL, *April 30, 1839.*

In order to distinguish the Northwest light-ship in Liverpool bay from all other lights in her vicinity, especially when the mariner is approaching in hazy weather, or at a distance when her three lights so blend in the eye as to appear but one, notice is hereby given, that a blue light, of two or three minutes' duration, will be exhibited from the said light ship regularly at the following periods, viz: During the months of November, December, January, and February, at 6, 8, 10, 12 p. m., 2, 4 and 6 o'clock, a. m.; during the months of March, April, September, and October, at 8, 10, 12 p. m., 2 and 4 o'clock, a. m.; during the months of May, June, July, and August, at 10, 12 p. m., and 2 o'clock, a. m.

The instant of ignition will be as near Liverpool *mean* time as possible, but those approaching under difference of time at ship, should look out around the anticipated bearing, five minutes before the respective hours.

By order of the Dock Committee,

WILLIAM LORD,
Marine Surveyor

LIVERPOOL LIFE-BEAT ESTABLISHMENT.

Return of services rendered during the years from 1830 to 1840, both inclusive.

	1840.		1841.		1842.		1843.		1844.		1845.		1846.		1847.		1848.		1849.		1850.		Totals.	
	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.	Vessels assisted.	Lives saved.
Liverpol.....	9	...	6	...	3	...	12	...	6	180	13	...	15	...	12	2	3	...	9	33	8	28	96	243
Magazines	7	20	4	...	6	5	9	5	12	7	13	...	15	214	15	6	3	...	13	...	9	33	106	290
Hoylake.....	4	1	5	143	3	...	6	3	3	...	7	37	12	6	2	...	4	4	8	...	5	7	59	201
Point of Ayr	7	7	3	140	3	4	5	2	6	20	10	113	8	15	2	...	5	10	7	5	4	16	60	332
Formby.....	4	29	2	...	8	...	5	...	13	...	13	7	8	20	6	...	4	3	7	...	5	3	70	62
Total.....	31	57	14	283	10	9	24	10	27	207	36	157	38	255	21	8	12	17	25	38	81	87	269	1,128

The total number of vessels assisted appears less than that given by the figures in the above columns, but this arises from two, and in some instances three boats having assisted the same vessel. This observation does not apply to the number of lives saved, which will be found to agree with the figures in the columns.

MARINE SURVEYOR'S OFFICE, January, 1851.

WM. LORD, Marine Surveyor.

MONTHLY ABSTRACT.

Date.		Oil.					Number of cylinders.	Number of wicks.	Lbs. of cotton waste.	No. cleaning leathers.
		Galls.	Qts.	Pints.	Half pints.	Gills.				
	Stores on hand as per last month.									
	Consumed this month									
	Remaining on hand, carried to next mos. account									

Lightkeeper.

*Account of stores consumed at the
extinguishing and exhibiting the light.*

light-house,

Day of the month.	Time of lighting.		Time of extinguishing the light.		How long exhibited.		Oil consumed.				
	Hour.	Min.	Hour.	Min.	Hour.	Min.	Galls.	Qts.	Pts.	Half pints.	Gills.
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
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19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
Total quantity consumed in the lamps of the light-house.....											
Total quantity consumed this month for use in the dwelling-house											
Total in this month.....											

[illegible]

RULES AND REGULATIONS.

Rules and regulations to be observed by the keepers of Bidston Light-house.

1. They must punctually light up at sunset, and extinguish at sunrise.
2. They are held responsible for the careful watching and trimming of the light throughout the night, and are expected to be in attendance during the day, never absenting themselves from duty without leave in writing from the chairman, or deputy-chairman, in which case they are to provide an efficient substitute ; any negligence will subject them to the committee's severest displeasure.
3. They are to note the time of all the other lights in their view lighting up, and whether they miss any of them (except through fog) during the night.
4. They are to take charge of all stores, oil, and lighting materials, keeping a strict account of the quantity daily consumed in a book provided for that purpose, and send a copy of the expenditure and stock remaining on hand at the end of each month, to the marine surveyor; and are cautioned not to waste or destroy, or permit any of the stores to be wasted or destroyed; and should any loss occur through their negligence or carelessness, the amount of such loss will be deducted from their salary.
5. They must send to the marine surveyor's office a list of any stores they may want, four days before-hand, at least, or giving such longer notice as will insure their timely delivery at the light-house.
6. They must request all visitors to enter their names in the visitor's book, stating by whose permission they inspect the light-house, and are to take care that they in no wise deface the building, scratch, or injure the reflectors, or fitments; and are by no means to permit strangers to remain alone in the light-room. They are strictly prohibited from soliciting or accepting money or presents of any kind, on pain of instant dismissal.
7. They are strictly forbidden to let apartments in the light-house, or to take in lodgers at any season of the year.
8. They are strongly cautioned against drunkenness, or irregularity of conduct, which will subject them to immediate dismissal.
9. They are to clean the plate glass within and without, by night as well as day, particularly from the drift snow and moisture which is apt to accumulate on the windows, and are to polish the reflectors, trim the lamps, and put the light-room in perfect order not later than 10 a. m. daily, and be very particular with the order and cleanliness of the building and premises.
10. They are to keep a constant look-out for vessels in distress, and on seeing any within probable reach of the life boats, are to hoist the distress flag, and note the time of so doing, and when they perceive assistance given.
11. If they perceive any accident to the light-vessels, beacons, or buoys, or illness, or unassisted wreck, takes place, (which they cannot communicate by signal,) they are to send information in writing to the marine surveyor's office, by messenger forthwith.
12. The fire buckets are to be kept constantly filled with water in the light-room, and they are on no account to be used for household purposes.

The water in them is to be changed frequently, and the keepers are strictly enjoined to use their utmost vigilance for the prevention of fire in the building and light-room.

By order of the committee,

WILLIAM LORD,
Marine Surveyor.

MARINE SURVEYOR'S OFFICE,
LIVERPOOL, *December 1, 1839.*

Rules and regulations for the management of the floating lights, moored off the port of Liverpool, made by the dock committee the 12th October, 1837, and to be observed by the masters and crews, on pain of instant dismissal, at the option of the said committee.

1. There shall be two masters to each vessel, with eleven seamen to the N. W. vessel, eight to the Formby, and six to the Crosby vessel, all subject to *either* vessel, as may be requisite.

2. There must, at all times, be one master, with seven seamen, on board the N. W. vessel, and one master, with five seamen, on board the Formby, and one master, with four seamen, on board the Crosby vessel, which will allow the masters to be, alternately, a month afloat and on shore; and the seamen two months on board to one on shore, except when illness or other causes may interfere with the regular relief.

3. The masters of the N. W. light-ship shall be allowed £110 per annum each, the masters of the Formby light-ship £100 per annum each, and the masters of the Crosby light-ship £90 per annum each, and the seamen shall be allowed £2 10s. per month each, and 2s. 6d. per month each, when on duty in the buoy tender.

4. Each master will be allowed the sum of sixteen shillings per week, and each seaman the sum of twelve shillings per week in lieu of provisions, whether on board or on shore. The money will be paid each fortnight in advance, and they are required to provide themselves with a stock suitable for their term of service afloat; subject to the directions of the marine surveyor as to the time of taking such provisions on board. Spirituous liquors of all kinds are strictly prohibited. In order to prevent the risk of want of provisions from bad weather, or any unforeseen occurrence, a barrel of pork and a barrel of bread will be placed on board each vessel in the care of the master, to be accounted for by him, and charged at prime cost to such of the men as may require to be supplied therefrom.

5. The masters shall be paid their salaries every quarter after the first four months, leaving one month in arrears, which will be forfeited if they quit the service without giving three months' previous notice to the marine surveyor, which notice shall be immediately reported to the dock committee. The seamen shall be paid every month after the first two months, leaving one month in hand, which will be forfeited if they quit the service without giving one month's previous notice. The pay of the masters and men will be subject to making good any loss or injury the vessel, her furniture, or stores, may sustain from their individual neglect or carelessness.

6. Each master and seaman shall be liable to do duty on board the buoy tender, and assist, whenever required, in placing and removing buoys in the

channels and harbor, and go on light-house and life-boat service when called upon by the marine surveyor, and are held responsible for the safe and prompt delivery of all stores committed to their charge.

7. A strict and careful inventory must be kept of each vessel's stores. Each master must examine them, and take the receipt of the succeeding master every month, bringing to the marine surveyor's office a copy of the charge of stores left on board, with a list of stores expended; and those required in lieu, according to the forms supplied; and this article of instruction equally applies to the duplicate vessels, which must be visited every day by the masters on shore, who are held responsible that each duplicate is kept ready, in every respect, to replace either ship at a tide's notice.

8. Each master and seaman must put his address on the public board in the marine surveyor's office; and each master on shore must muster his shore party on board each duplicate vessel, and report himself at the same office every morning, by nine o'clock, and state where he is to be found during that day; and each master, alternately, must inquire for orders every evening at four o'clock, when not otherwise employed by the marine surveyor.

9. In keeping the account of stores, and bringing monthly returns to the marine surveyor, care must be taken not to confuse the lighting stores with the ship's stores; and no part of either must be allowed to run within a fortnight's expenditure. Separate forms will be supplied for demanding lantern and ship stores, and if anything is required *forthwith*, it must be stated in red ink.

10. Each master must take especial care that the lamps and lanterns are constantly kept clean and in good order, as well as every other material belonging to the vessel; and that the lights are properly exhibited every night from sunset to sunrise.

11. Each master must take care that the oil is always emptied into the cistern, and all stores properly stowed away as soon as received on board; and that none are embezzled, stolen, wasted, or lost, as the value of such as may be missing will be deducted from his salary, unless satisfactorily traced or accounted for.

12. Each master must keep a journal of all occurrences and observations according to the form supplied, which is to be read every day at noon to the crew, and signed by the master and senior seaman, so that the occurrences of the night may be faithfully given, as observed by the watch on deck.

13. Each seaman shall be distinguished by a number, according to the marine surveyor's selection, which must guide their seniority, and prevent confusion in case of death or accident to the master; No. 1 being first, No. 2 second, and so on in command.

14. Each master must, at every opportunity, carefully examine the state of the moorings, by sighting them as far down as possible, inserting in the log-book how he finds them; and he must examine the bridles and swivels every day, taking care to have spare shackles and forelocks on board.

15. Should the vessel part from her moorings totally, the ball by day or lights by night must be instantly struck; but, if only parting one leg of the moorings, the lights and ball are to be exhibited until she so drives as to open the marks and render her a false object. In each case, the distress-signals appointed are to be shown, and every step taken to send prompt information to the marine surveyor's office by the master, who must exert

all his skill in endeavoring to save the vessel and crew; and he must be careful in seeing his stay-sails ready, the spare anchors clear, the cables ranged, and deep-sea lead dropped over the side, every evening, to detect driving in thick weather, after mustering his crew, to see if they are sober and orderly.

16. Each master must be extremely careful of fire and lights—he must frequently visit the fore cabins, and when the inclemency of the weather requires a continuance of fire in the night, he must see that it is within bounds and safe. The fire-buckets are to be filled every evening, and the crew are to be stationed so as to make the best use of them in case of fire.

17. The master of the northwest light-vessel must pay particular attention to the punctual burning of the blue lights at the appointed times, and must on no account allow any body but himself to interfere with the stock, but give out the required number for each night, which must be kept distinct from the stock; and none of the blue lights are ever to be taken below.

18. Each master must be vigilant throughout the day, attending to the signals established for communicating with the tender and telegraphs respecting buoys, distressed vessels, &c. The gong belonging to the northwest light-vessel is to be struck every five minutes in foggy weather, and the signal gun must be fired in reply to the government mail-boat's gun. The time on board is to be corrected daily by the one o'clock signal at Helbree island, and the state of wind and sea must be telegraphed every day two hours before, and at high water. The bell belonging to the Formby light-vessel must be rung at intervals of five minutes during fog, and the master must note most carefully (according to the form supplied) the vessels that pass through the new channel, both inward and outward bound, whether by night or day: and each master is to send as much information by telegraph as circumstances may require and weather permit.

19. Each master must be at all calls in the night. He must appoint the watch each evening, and enter their names in the column of the log-book. He must be called at the end of each watch, and attend the fresh trimming of the lights, taking care that a signal lantern replaces the large lantern whilst down. The half-hours must be regularly struck on the bell.

20. Each vessel must be kept thoroughly clean, but the decks must not be *stoned* more than once a month, and as little water *sluiced* about below as possible. All wetting must be done in the forenoon, so as to be thoroughly dry below by nightfall.

21. Each seaman is required promptly to obey the orders of the marine surveyor and of the masters, whether on board or on shore, and also be ready to obey any order for the good of the service from any of the officers of the dock estate; and in the event of any seaman misbehaving himself, or in anywise disobeying orders, the master must immediately report the same to the marine surveyor.

22. Each master must, by his own example and attention, enforce through cleanliness of person, total freedom from foul language, and strict sobriety; every man is expected to be decently dressed, to air his bedding on deck every day, and is recommended to attend morning and evening prayers each day in the cabin.

23. Neither the masters nor any of the crew shall, on any pretence whatever, go on shore or quit the vessel during the time of their service on board their respective vessels, unless called by signal from the tender.

24. Each master must take care that neither he nor any of his men be concerned in aiding or assisting others in running any goods out of any ship, vessel or boat, to the prejudice of her majesty's revenue ; and he must not suffer goods of any kind, nor spirituous liquors, to be brought on board the light vessel, or tender, from any ship or vessel whatever, except from vessels in distress, and, in that case, he must take care there is no embezzlement or damage, or practices whatever, that may prejudice the owners or the crown ; and he must enter all occurrences of this nature in his journal, and report the same to the marine surveyor.

25. Should any distressed crew be compelled to take refuge on board either of the light-vessels, the master must provision them in the same manner as his own crew, taking particular care to insert in his journal (and in a special letter to the marine surveyor) their names and the name of the vessel to which they belonged. But the master must not on any account, suffer any pilots to remain on board the light-ships, if there be any means of sending them on shore ; he must not, however, put them on shore with the vessel's boat, nor allow any signals to be made that might confuse the regular telegraphic code. Strangers, boatmen, fishermen, or other persons must not be permitted to board the light-vessel, unless they are in circumstances of danger, and, in such case, the master must insert their names, and fully state the circumstances in his journal.

26. The masters must endeavor to hail any steam-vessels which may be lying or hovering near the floating lights, so as to prevent, as much as possible, the lights from being obscured by their smoke or steam, and they must not permit any vessel to come alongside, or make fast to the light ships.

27. Each master must sign and agree to the foregoing instructions and regulations on being appointed.

Liverpool Life-boats.

The dock committee have established five life-boat stations, viz : At Liverpool, on Waterloo pier-head, two boats ; at Magazines, two boats ; at Hoylake (Hoylake one boat, Helbre Island one boat,) two boats ; at Point of Ayr, two boats ; at Formby, one boat.

Liverpool.—The Liverpool life-boat's crew consists of one master (Peter Cropper,) and ten men. Keys of the life-boat house are kept at the following places, viz : At the marine surveyor's office, dock office, Revenue buildings ; at the dock yard, Coburg dock ; at the dock master's office, Waterloo dock ; and at the life-boat master's house, St. Mary's Place, Pickop street, Marybone.

Magazines.—One master (Thomas Evans,) and ten men. The key of the life-boat house is kept at the Magazine gunpowder office, kept by Mr. Leay.

Hoylake.—One master (George Davies,) and twelve men. The key of the life-boat house is kept at the lower Hoylake light-house.

Point of Ayr.—One master (Robert Beck,) and twelve men. The key is kept at the master of the life-boat's house.

Formby.—One master (Joseph Formby,) and twelve men. The key is kept at the life-boat house by the keeper.

General rules and regulations for the management of the life-boats belonging to the port of Liverpool, made by the Dock Committee, November, 1839, and to be observed by the masters and crews, on pain of instant dismissal, at the option of said committee:

1. The master shall be allowed £7 10s. per annum, and each boatman £5 5s. per annum.
2. There shall be one exercising day in each month, on the second of the month, if practicable, for which the master shall receive 10s., and each boatman 7s. 6d., and they shall be paid the like sum per diem, when called to assist wrecks or other extra duty.
3. The master and crew shall be paid their salaries quarterly, after the first four months, leaving one month in arrears, which will be forfeited if they quit the service without giving one month's previous notice, or on refusing to go on duty in the life-boat when ordered by the marine surveyor, superintendent at the station, or by the master of the boat, or for any injury the boat or her gear may sustain from their individual neglect or carelessness.
4. The master is to keep an inventory of the boat's gear and stores, a copy of which will also be kept in the marine surveyor's office; and when any of the boat's gear is lost, broken, or otherwise injured or worn out, he is to give immediate information of the same to the marine surveyor, as also of any injury the boat herself may receive, in order that the same may be made good forthwith.
5. The master and each of the men will be allowed an oiled canvass coat and hat, or south-wester, which is to be worn when on duty in the boats, but at no other time, the same to be carefully hung up on the man's peg, in the life-boat house, on his return from duty, and each man will be held responsible for keeping his own in good order.
6. The master and each of the men shall be distinguished by a number at the marine surveyor's selection, the same to guide seniority and prevent confusion, in the event of death or accident to the master. The master No. 1, being the first; No. 2, second; and so on in command—the said numbers to be painted on their coats, hats, pegs, and oars, and also to apply to their seats in the boat, beginning from aft, so that there may be no confusion.
7. Immediately on perceiving any vessel in distress, or seeing the life-boat's signal (a blue flag) flying at any of the stations, the master is to use his best endeavors to assemble his crew, launch his boat, and proceed to her assistance; and, in the event of any of his crew being absent, he is to select the best volunteers he can get on the spot, who shall be paid the same as the boat's crew.
8. On boarding wrecks, the preservation of life is to be the master's first consideration, and he is on no account to take in any goods, merchandise, luggage, or other articles, which may endanger the safety of his boat, and the lives of those entrusted to his charge.
9. On returning from duty, the boat is on no account to be left thumping on the beach, but is to be immediately got on her carriage, and placed in the boat-house. The master will be accountable for the due execution of this order.
10. The master will be held responsible for the neatness, efficiency and general good order of the boat and her gear; and it is hoped that a spirit

of emulation will lead the masters and crews to vie with each other on these points, and in the celerity and seaman-like manner in which their boats are handled; and no materials but those belonging to the life-boat are to be deposited in the boat-house.

11. The master is to enter in a journal, with which he will be supplied, all services performed by his boat—stating the time of launching, time of reaching the wreck, vessel's name, to what port belonging, whither bound, master's name, cargo, and number of persons rescued.

12. The crew are strictly enjoined to obey the orders of the master; or, in his absence, of the senior boatman; and any infringement of this order will be followed by the dismissal of the offending party.

By order of the committee,

WM. LORD, *Marine Surveyor*.

LIVERPOOL DOCK OFFICE, *January 1, 1851.*

Directions for the management of the reflecting lights on board the light-vessels.

When the lamps are extinguished at sunrising, the lanterns are to be lowered down immediately; and as soon as practicable afterwards, the lamplighters will commence the daily process of trimming the lamps and cleaning the reflectors, observing strictly the following directions:

To trim the lamps.—Cleanse them thoroughly in every part, occasionally rinsing out the reservoirs and tubes with hot oil: the glass cylinders must be made perfectly clean, and free from stains. Fill the reservoirs with oil, and put in fresh cotton wicks if required, taking care always to cut them quite even at the top. The gimbal work must be kept perfectly bright and free from rust.

To clean and polish the reflectors.—The materials from London must be used, and no others. Remove the reflectors carefully from the frame into the tin boxes, and carry them into the oil room. If the back or copper side be tarnished, place them on a table or stand provided for that purpose with that side uppermost; mix a little of the prepared Tripoli powder in some waste oil, and apply it with a woollen rubber, rubbing smartly till the tarnish is removed, then clean it off with some dry powder and another rubber; this will be required twice or three times a week, according to the weather and state of the lantern.

The reflector must then be placed in the stand with the face or silver side upwards, and polished with the utmost care, as upon this the brilliancy and efficiency of the light materially depend:—having taken off the dust or burnt particles of cotton wick with a reflector cloth, moisten a small quantity of the rouge powder with the rectified spirits of wine, not more than sufficient for a day's use, and apply it with a soft leather to the silver, rubbing it all over in right lines up and down with its apparent grain, and before it is dry polish it off with a dry leather and a little dry rouge powder, rubbing it briskly till it becomes brilliant, and perfectly free from tarnish or stains. This will probably be required about once in a week; at other times, when the silver is not much discolored, it will be sufficient to apply a little dry rouge powder in a soft bag lightly, breathing on it at the same time, and then to polish it off with a clean dry leather.

The leathers and polishing powders are to be kept in the store cases, free from damp and dust. In using the leathers great care must be taken to fold them smooth, without crease or uneven surface, and that no grit or hard substance adheres to them to scratch or injure the surface of the silver; and no leather which has been washed or wetted with water must on any account be made use of for the reflectors.

When all are completed ready for lighting, the lantern must be cleansed with water where requisite, care being taken that no dust is allowed to settle on the reflectors after they are polished. If the roof, or other internal parts of the lantern require washing, it should be done early in the day, that they may be thoroughly dry before the evening. In cold weather the oil must be kept warm below, and only put into the lamps immediately before sunset that it may be in a sufficiently liquid state: the glass cylinders also should be warmed before they are placed on the lamps, and at all times the flame must be increased very gradually.

The best height for the flame is one inch and a quarter, and not exceeding one inch and a half; and it should be frequently attended to, and kept free from smoky points. The ventilators of the lantern must be made use of at the discretion of the officer in charge, and the lamplighter.

TRINITY HOUSE, LONDON, *May, 1841.*

TRINITY HOUSE, LONDON.

Inventory of stores for a light vessel.

Now on board the ———. No. —.

Mast maker.

Mainmast 16 inches diameter, 69 feet long,
with oak battens, and 18-feet mast head,
with lightning conductor complete.....
1 lug yard 24 feet long, at the out stations.
1 ensign staff 17 feet long.....
2 vane staffs 10 feet long.....
Mast for long boat, 18 feet long.....
Yard for....do....11 feet long.....

If more than one mast—

Foremast 16 inches diameter.....
Mizenmast 16 inches diameter.....

6 16-feet ash oars.....
4 12-feet...do.....
4 boat-hooks, 2 of 12 feet and 2 of 10 feet.
3 boat scoops.....
6 hickory handspikes, 6 feet long.....
1 lignum vitæ fid, for splicing.....
1 serving mallet.....
1 deep-sea reel.....
1 log reel and 2 current logships.....

Block maker.—(Stamp, Trinity House.)

1 threefold purchase block, 10 in. dia. sheave
2 double cat blocks..... 7.....do.....
2 double fish tackle blocks..... 8.....do.....
1 snatch block..... 6.....do.....
2 staysail halyard blocks.. 5.....do.....
2 staysail sheet blocks.... 5.....do.....
1 staysail downhaul block. 3 $\frac{3}{4}$do.....
2 double luff tackle blocks 5.....do.....
2 single luff tackle blocks. 5.....do.....
3 single burton blocks.... 5.....do.....
4 single rudder pendant
blocks..... 4 $\frac{1}{2}$do.....
2 single tiller rope blocks. 3 $\frac{3}{4}$do.....
4 single gun tackle blocks. 3 $\frac{3}{4}$do.....
6 double boat's davit tackle
blocks..... 5.....do.....
2 single boat's davit tackle
blocks..... 4 $\frac{1}{2}$do.....
4 single boat's davit guy
blocks..... 3.....do.....
2 spare double blocks.... 5.....do.....
2 spare single blocks.... 5.....do.....
2 spare single blocks.... 3 $\frac{3}{4}$do.....
1 single signal halyard
block..... 2 $\frac{1}{2}$do.....
1 deep sea line snatch block.....

For each mast—

2 lantern preventer tye
blocks..... 5.....do.....

Anchor smith.—(Stamp, Trinity House.)

1 bower anchor, stock included, 20 cwt....

1 spare anchor.....14 cwt.....
1 kedge..... 2 do.....
1 smaller anchor.... 1 do.....
1 creeper..... $\frac{1}{4}$ do.....
1 boat's anchor..... $\frac{1}{4}$ do.....

Mooring as required—

Mushrooms, 32 cwt.....
One-arm anchors.....

Cables, one-and-a-half-inch—

1 bridle or riding chain.....
1 bower riding chain.....
2 cable claw hooks.....
6 connecting shackles, 1 $\frac{1}{2}$ -inch.....
1 fish hook.....
2 shank painters, 13 ft. 6 in. long, $\frac{1}{2}$ -inch
tapered.....
2 stoppers, 13 ft. 6 in. long, $\frac{1}{2}$ -inch tapered.
12 chain hand-hooks.....
1 large 2-feet wrench hammer.....
1 small 18-inch....do.....
2 starting hammers.....
2 clench....do.....
1 double-headed maul.....
6 cold chisels.....
6 chain punches.....
12 spare cable pins.....

Chains and gear for each mast—

6 shrouds, $\frac{5}{8}$ -inch, with screws for setting up.
1 forestay.....do.....do.....
1 backstay.....do.....do.....
1 triangle block, with a 6 $\frac{1}{2}$ sheave by 2 $\frac{1}{2}$...
1 pair iron cheek blocks, 6 in. sheaves by 2 $\frac{1}{2}$.
2 lantern tyes, $\frac{1}{2}$ -inch.....
1 lantern fall, $\frac{5}{8}$ or $\frac{1}{2}$ -inch.....
2 Jacob's ladders.....
2 spare shrouds, $\frac{5}{8}$ -inch.....
2 spare lantern tyes, $\frac{1}{2}$ -inch.....
1 spare lantern fall, $\frac{5}{8}$ or $\frac{1}{2}$ -inch.....
12 clasp connecting shackles for tyes.....
1 wooden globe in two halves, with hanging
hooks and staple plates.....
1 spare collapsing globe in two halves, with
hanging hooks and staple plates.....
6 chain boats davit guys, $\frac{1}{4}$ -inch.....
2 composition rudder chains, $\frac{5}{8}$ -in., 8 ft. long.

Rope maker.

1 5-inch hawser.....
1 3 $\frac{1}{2}$ -inch warp.....
1 buoy rope, 25 fathoms, 5-inch water-laid
rope.....
1 hawling line for boats, 120 fathoms, 2-in.
1 coir line, 3 $\frac{3}{4}$ -inch at the out stations....
 $\frac{1}{4}$ coil of 5-inch rope for stoppers, pen-
dants, &c.....

*Inventory of stores—Continued.**Rope maker—Continued.*

- $\frac{1}{4}$ coil of $3\frac{1}{2}$ -inch rope for rudder and fish pendants
- 1 coil of 3-inch rope for purchase falls, preventer ties, &c
- 1 coil of $2\frac{1}{2}$ -inch rope for boat and luff tackle falls, &c
- 1 coil of $2\frac{1}{4}$ -inch rope for small boat's falls.
- 1 coil of 2-inch rope for preventer falls, staysail halyards, &c
- 1 coil of $1\frac{1}{2}$ -inch rope for staysail sheets, downhauls, &c
- $\frac{1}{2}$ coil of 12 threads, rudder, pendant-falls, &c
- $\frac{1}{2}$ coil of 6 threads for signal halyards
- 56 pounds spunyarn
- 2 hand lead lines, 20 fathoms long
- 1 deep-sea lead line, 120...do
- 6 log lines
- 2 pounds sewing and 2 pounds whipping twine

Sailmaker.—(Stamp, Trinity House.)

- 1 lug sail and cover, at the out stations ...
- 1 fore staysail
- 1 long boat's lug sail
- Awnings complete
- 1 windsail
- 18 hammocks
- 6 duck table-cloths
- 25 coal bags
- 2 cork fenders
- 20 yards new canvass, No. —
- 40 yards old canvass, No. —
- 1 collapsing globe cover
- 1 skylight cover for each skylight
- 1 winch cover for each winch
- 1 gong cover

Boat-builder.

- 1 long boat, copper fastened, 20 feet long, 6 feet 9 inches broad, and 2 feet 8 inches deep, clinch built, with stern davit, rudder, tiller, complete
- 1 double-headed boat, copper fastened, 16 feet long, 6 feet 3 inches broad, and 2 feet 2 inches deep, with rudder, &c., complete.

Cooper.—(Stamp, Trinity House.)

- 4 harness casks, with locks and keys
- 2 bread casks, 1 cwt. each..do
- 1 flour cask
- 1 pea cask
- 30 water casks, to contain 9 gallons each..
- 1 wash deck tub
- 8 buckets
- 2 wash kids
- 2 bread kids
- 2 water funnels with iron pipes

- 1 oilfunnellined with lead, and long lead pipe.
- 1 small wood nun-buoy

Light apparatus and stores.—(Stamp, Trinity House.)

- 1 lantern complete for each mast, with lamps and reflectors, according to the character of the light
- Spare lamps and reflectors as required, with brackets or cups
- Spare rack wickholders, pinions and wrench.
- 4 oil cisterns, to contain 80 gallons each...
- 8 oil drippers
- 1 set copper oil measures, 1 gall. to 1 gill..
- 1 $\frac{1}{2}$ -gallon copper oil-feeder
- 1 pint.....do
- 1 pint copper funnel
- 1 copper trimming tray
- 2 lighting torches
- 1 galley lamp with gimbal
- 1 cabin lamp.....do
- 1 oil-room lamp.do
- 1 binnacle lamp
- 1 spare lamp
- 1 copper stand for binnacle
- 1 copper lantern
- 1 copper reflector box
- 2 japanned boxes
- 1 cylinder box for each lantern
- 2 pair trimming scissors
- 2 mandrills
- Spanners
- Cylinder wires
- Wick holders
- Trimming wires
- Rape oil
- Glass cylinders
- Cotton wicks
- Balls of cotton
- Reflector cloths
- Glass cloths
- Leathers
- Woollen rubbers
- Tow
- Cotton wipings
- Polishing powder for reflectors
- Do.....for copper
- Do.....for brass
- Bags of polishing powder
- Flexible brushes
- 1 plough diamond
- 2 spare squares of glass for lantern
- 2....do.....do...for doors of lantern.
- 14 pounds cement for plate glass
- 2 putty knives
- 1 hand vice
- 1 screw-driver
- 1 flat file
- 1 round file
- 1 half-round file
- 1 pair of soldering irons
- 7 pounds of solder
- $\frac{1}{2}$ pint of spirit of salts

*Inventory of stores—Continued.**Water tanks.*

8 wrought iron, connected by leaden pipes, with brass screws, to contain 1,700 galls.

Ironmonger.—(Stamp, Trinity House.

1 12-pound carronade.....
 1 copper powder magazine.....
 1 copper powder measure.....
 1 copper powder primer.....
 A crane for each mast.....
 1 long japanned speaking trumpet.....
 1 short....do.do.....do.....
 1 iron anchor buoy.....
 1 branding iron, with number of vessel....
 18 hanks for stay, 4 inches in the clear....
 2 dozen hooks and thimbles.....
 1 dozen welded thimbles.....
 4 tin paint-pots.....
 4 marline spikes.....
 1 pitch-pot and ladle.....
 1 small chopper.....
 2 crow bars.....
 2 ballast shovels.....
 6 scrapers.....
 Set of carpenter's tools, as per list.....
 6 pair brass butt hinges and screws.....
 6 pair of H hinges.....
 1,000 4d. clasp nails.....
 1,000 6d. clasp nails.....
 1,000 10d. clasp nails.....
 1,000 20d. clasp nails.....
 1,000 pump tacks.....
 1,000 brads, (assorted).....
 1,000 1½-inch boat nails.....
 1,000 ⅝-inch copper tacks.....
 250 batten nails.....
 250 copper rooves.....
 250 iron screws, (assorted).....
 250 copper screws.....
 28 pounds spike nails, assorted.....
 56 pounds of 4-pound sheet lead.....

Galley—

1 cook's hearth, with cheeks, copper funnel with T top, tormenters, ladle, poker, rake, shovel, hanging-plate and steamer..
 1 coal-hod, and 1 pair bellows.....
 1 iron tea kettle.....
 1 coffee pot.....
 2 tin baking pans.....
 3 oval tin dishes.....
 9 metal mess-plates.....
 9 round mess-tins.....
 9 hook pots.....
 1 hook for warming pot.....
 9 pannikins.....
 9 iron spoons and 1 salt cellar.....
 1 oval iron saucepan.....
 1 round iron saucepan.....
 1 frying pan, and 1 gridiron.....
 1 pair brass steelyards.....

1 set of weights and scales, (the weights from 2 ounces to 14 pounds).....
 1 bread sieve.....
 2 brass beer taps.....
 1 meat saw, and 1 hand saw.....
 1 meat chopper and 1 cook's axe.....
 1 tinder box.....

Cabin—

1 cabin stove complete, copper funnel for ditto, and T top, copper ash-pan and wire guard.....
 1 set fire irons.....
 1 coal hod.....
 1 metal tea-pot and 1 coffee-pot.....
 3 knives and forks.....
 1 carving knife and fork.....
 3 of each, metal table and tea spoons.....
 1 small metal tureen and ladle.....
 1 set of cruets.....
 1 salt cellar and 1 sugar box.....
 1 tea canister.....
 1 bread tray.....
 1 pint black jack.....
 2 metal wash-hand basins and 2 ewers....
 1 dust pan.....

Ship chandler.—(Stamp, Trinity House.)

1 rammer and sponge for 12-pound carronade.....
 1 ladle and worm for 12-pound carronade..
 100 flannel cartridges filled.....
 Gunpowder.....
 1 powder horn.....
 1 Trinity ensign, 3½ yards.....
 1 set signal flags.....
 2 deep sea-leads, 28 pounds and 36 pounds..
 2 hand sea-leads, 11 pounds.....
 1 grindstone and trough.....
 4 paint work scrubbers.....
 4 long-handle deck scrubbers.....
 2 long-handle tar brushes.....
 2 short handle tar brushes.....
 4 paint brushes.....
 2 tools.....
 4 mops.....
 2 long-handle hair brooms.....
 2 dozen heath brooms.....
 2 banister brushes.....
 1 set black lead brushes.....
 6 hand scrubbing brushes.....
 9 yards dwelling.....
 6 holy stones.....
 2 Bath bricks.....
 2 yards red bunting.....
 3 yards green baize.....
 25 sail needles.....
 25 sewing needles.....
 ¼ pound mixed thread.....
 1 palm.....
 6 pounds pump leather.....
 Half a tanned hide.....

Inventory of stores—Continued.

2 pounds thrums for pitch mops.....
 7 pounds rosin.....
 2 gallons stockholm tar.....

Cabin—

3 cups and saucers.....
 3 soup plates.....
 3 flat plates.....
 2 dishes, 10 and 12 inches.....
 3 tumblers.....
 3 wine glasses.....
 1 green baize table cover.....

Stationery.

1 log book.....
 2 half yearly journals.....
 Almanac for the year.....
 1 tidal journal.....
 Oil and light store accounts.....
 1 store expenditure book.....
 Framed instructions for masters and mates.
 2 framed lists of rations.....
 1 framed list of books.....
 11 Bibles and prayer books.....
 Library, containing 18 volumes ..
 1 signal book.....
 1 chart of the station.....
 1 log slate.....
 1 inkstand marked "Trinity House.".....
 1 pair parallel rulers, 18 inches, marked
 "Trinity House.".....
 1 2-foot ruler, marked "Trinity House."..
 1 Gunter scale, marked "Trinity House."..
 1 pair of dividers, marked "Trinity House."..
 1 portfolio and stationery.....
 1 package of slate pencils.....

Cabin furniture—

1 oak table.....
 3 chairs.....
 1 looking glass, 14 inches by 12, in a black
 frame.....

Compasses.

1 brass steering compass.....
 1 wooden box compass.....
 1 brass hanging compass for cabin.....

1 medicine chest.....
 1 time-piece and hood.....
 1 Aneroid barometer, with a thermometer
 2 28-second log glasses.....
 1 spyglass, marked "Trinity House.".....
 1 gong and sticks.....
 1 life buoy.....

Paint Stores.

3 cwt. of red lead and venetian, in powder,
 mixed in the proportion of two of red
 lead to one of venetian ..
 2 cwt. stone color.....
 1½ cwt. white lead.....
 ¼ cwt. of black paint.....
 7 pounds litharge and 7 of copperas for
 driers.....
 18 gallons boiled oil.....
 18 gallons raw oil.....
 6 gallons turpentine.....
 28 pounds of tallow.....
 56 pounds soap.....
 6 gallons black varnish.....
 6 gallons bright varnish.....

TRINITY HOUSE, LONDON.

Account of oil consumed at the light, in the month of _____, 18____; also the time (in hours and minutes) of lighting, extinguishing, and exhibiting the light, with the number of cylinders broken and cotton wicks consumed each night; the state of the weather, &c.: an account of all which is directed to be accurately kept and carefully inserted.

Days of the month.	Time of lighting.		Time of extinguishing light.		How long exhibited.		Oil consumed.					Cylinders broken.	Cotton wicks consumed.	State of weather, and other observations.
	Hours.	Minutes.	Hours.	Minutes.	Hours.	Minutes.	Gallons.	Quarts.	Pints.	Half-pints.	Gills.			
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
Total quantity consumed in the lantern of the light-house														
* Total quantity consumed this month for use in the dwelling-house														
Total in this month														

* The account of the quantity of oil consumed in the dwelling-house must be kept wholly distinct in future, and cannot be allowed in any way to interfere with the statement of the quantity consumed in the exhibition of the light.

Lightkeeper.

Lightkeeper's account of receipts and expenditure of oil.

	Gallons.	Quarts.	Pints.	Half pints.	Gills.		Gallons.	Quarts.	Pints.	Half pints.	Gills.
To oil remaining at the light-house the 1st of this month..						By oil consumed this month.....					
To oil received at the light-house this month						By oil returned.....					
						By oil remaining at the light-house....					
Total						Total					

Agent's account of receipts, &c.

	Gallons.	Quarts.	Pints.	Half Pints.	Gills.		Gallons.	Quarts.	Pints.	Half pints.	Gills.
To oil in store in the warehouse 1st this month						By oil sent to the light-house					
To oil received.....						By thick oil returned					
						By oil remaining in store*					
Total						Total					

* I have personally inspected and ascertained the accuracy of the quantities of oil stated to be remaining, prior to affixing my signature hereto.

Agent.

List of stores wanting.

TRINITY HOUSE, LONDON.

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Account of buoys, chains, and sinkers, received and expended in the half year, ending the — day of —. District of —

	Buoys of—						Chains of—					Sinkers of—			
	10 feet.	8 feet.	7 feet.	6 feet.	4 feet.		18 fath.	16 fath.	14 fath.	12 fath.	10 fath.	14 cwt.	12 cwt.	10 cwt.	8 cwt.
In store per last return															
Received.															
[Here state the particulars of the receipt of any buoys, chains, or sinkers, whether the same may arise from a supply from London, or by old buoys, &c., being returned into store for new ones laid, observing to give the dates thereof.]															
Total															
Expended.															
[Here give the particulars of the purpose for which any of the above articles may have been disposed of, whether for a new station, to replace any gone, or any shifted, stating the dates of such proceedings.]															
Total expended															
In store															
Supply required															

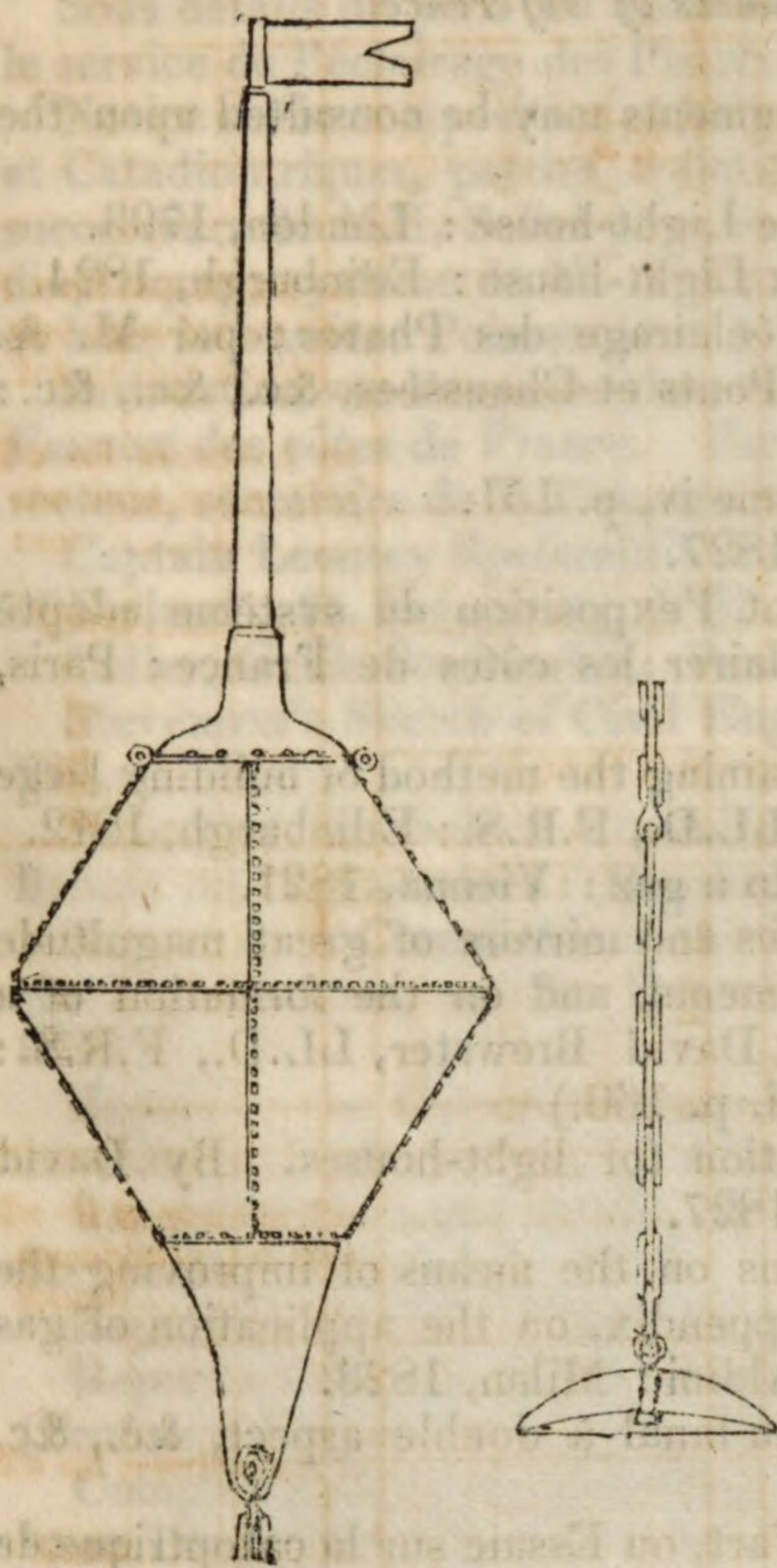
Agent.

Signed,

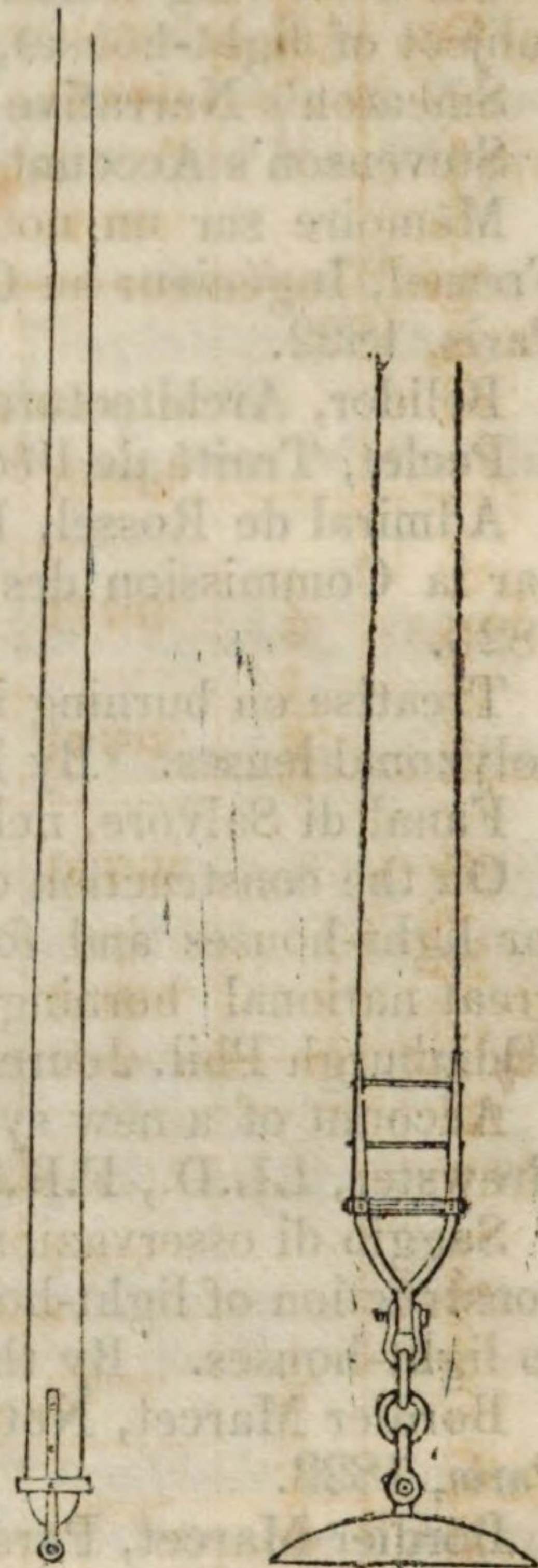
18 .

day of

*U. S. iron buoy and sinker as placed
in Columbia river, Oregon.*



U. S. spar buoy and moorings.



APPENDIX R.

Books and public documents of reference.

The following works, reports and documents may be consulted upon the subject of light-houses, viz :

Smeaton's Narrative of the Eddystone Light-house : London, 1793.

Stevenson's Account of the Bell Rock Light-house : Edinburgh, 1824.

Mémoire sur un nouveau système d'éclairage des Phares ; par M. A. Fresnel, Ingénieur au Corps Royal des Ponts et Chaussées, &c., &c., &c. : Paris, 1822.

Belidor, Architecture Hydraulique, tome iv, p. 151.

Peclet, Traité de l'éclairage : Paris, 1827.

Admiral de Rossel, Rapport contenant l'exposition du système adopté par la Commission des Phares pour éclairer les côtes de France : Paris, 1825.

Treatise on burning instruments, containing the method of building large polyzonal lenses. By David Brewster, LL.D., F.R.S. : Edinburgh, 1812.

Fanal di Salvore, nell'Istria, illuminato a gaz : Vienna, 1821.

On the construction of polyzonal lenses and mirrors of great magnitude for light-houses and for burning instruments, and on the formation of a great national burning apparatus. By David Brewster, LL.D., F.R.S. : (Edinburgh Phil. Journal, 1823, vol. viii, p. 160.)

Account of a new system of illumination for light-houses. By David Brewster, LL.D., F.R.S. Edinburgh, 1827.

Saggio di osservazione, or observations on the means of improving the construction of light-houses ; with an appendix, on the application of gas to light-houses. By the Chevalier G. Aldini : Milan, 1823.

Bordier Marcet, Notice descriptif d'un fanal à double aspect, &c., &c. Paris, 1823.

Bordier Marcet, Parabole soumise à l'art, ou Essaie sur la catoptrique de l'éclairage : Paris, 1819.

Description Sommaire des Phares et Fanaux allumés sur les côtes de France : Paris, 1845.

Stevenson's British Pharos : Leith, 1831.

The Light-houses of the British Islands, corrected at the admiralty, to October, 1844.

The Belgian, Netherlands, Hanoverian, Danish, Prussian, Swedish, Norwegian, Ionian Isles, and Russian light-houses : London, 1843.

The Light-houses, Beacons, and Floating Lights of the United States : Washington, 1845.

Instruction pour le service des Phares Lenticulaires. Par Léonor Fresnel, ingénieur-en-chef, secrétaire de la Commission des Phares : Paris, 1835.

Clauses et Conditions relatives à la fourniture, pendant trois années, de l'huile de colza nécessaire au service de l'éclairage des Phares et Fanaux des côtes de la Manche, 1839.

Detail estimatif de la dépense annuelle de la fourniture en huile de colza nécessaire au service de l'éclairage des Phares et Fanaux des côtes de la Manche : Paris, 1839.

Clauses et conditions de l'entreprise de l'éclairage des Phares et Fanaux des côtes de l'océan, et de la Méditerranée : Paris, 1838.

Tableau de service de l'éclairage des Phares de l'océan : Paris, 1838.

Detail estimatif des dépenses annuelles du service de l'éclairage des Phares et Fanaux des côtes de France : Paris, 1839, 1848.

Sous details du prix des diverses fournitures et des dépenses à faire pour le service de l'éclairage des Phares et Fanaux des côtes de France, 1838.

Notice sur la composition et les prix des Phares Lenticulaires, Catoptriques et Catadioptriques, parties optique et mécanique, par Létourneau et Cie., successeurs de MM. Soliel père, et François, jeune, constructeurs de Phares dioptriques, système de M. A. Fresnel, Rue des Poissonniers No. 24, près et hors la barrière Poissonnière, à Paris.

Instruction sur l'organisation et la surveillance du service des Phares et Fanaux des côtes de France. Par Léonor Fresnel, l'ingénieur-en-chef, directeur, secrétaire de la Commission des Phares : Paris, 1842.

Captain Leontey Spafareiff's New Guide for the Navigation of the Gulf of Finland : St. Petersburg, 1813.

Colier, Guide des Marins : Paris, 1825.

Stevenson's Sketch of Civil Engineering in America : London, 1838, p. 296.

Report of the Select Committee of the House of Commons of Great Britain on Light-houses : Hansard, London, 1834.

Report by a Committee of the Board to the Commissioners of the Northern Light-houses, on the Report of the Select Committee : Edinburgh, 1836.

Report to the Commissioners of the Northern Light-houses on the illumination of Light-houses, by Alan Stevenson, M. A. : Edinburgh, 1834.

Report to the same board, on the Inchkeith Dioptric Light, by Alan Stevenson : Edinburgh, 1835.

Report on the Isle of May Dioptric Light, by Alan Stevenson : 1836.

Report on the Isle of May Light, by a Committee of the Royal Society, (Professor Forbes, reporter :) Edinburgh, 1836.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, tome 18, p. 25 : Mémoire présenté à l'Académie des Sciences le 8 Janvier, 1844.

Note sur l'Appareil Catadioptrique exécutée par M. François, jeune, pour le Phare Ecossais de Scherivore : Commissaires MM. Arago, Mathieu, Babinet.

Report of the Select Committee of the House of Commons of Great Britain upon Light-houses : Hansard, London, 1845.

Captain Denham, R. N., Mersey and Dee Navigation : Liverpool, 1840.

Encyclopædia Britannica, 7th edition : Edinburgh, 1842 ; vol. xx, article Sea-lights, page 15.

Circular : Instruction sur la Nouvelle Organisation de l'éclairage des Phares et Fanaux : Paris, le 25 Juin, 1839.

Circular : the same subject : Paris, le 28 Juin, 1839.

Circular : Phares et Fanaux ; Contrôle des consommations en huile et de la situation des divers approvisionnement : Paris, le 17 Mars, 1845.

Document H. R., 2d session 25th Congress, No. 21.

Do. do. do. No. 27.

Do. do. do. No. 38.

Do. do. do. No. 41.

Document Senate, 2d session 25th Congress, No. 138.

Do. do. do. No. 159.

- Document Senate, 2d session 25th Congress, No. 428.
 Do. do. do. No. 375.
 Do. do. do. No. 506.
 Do. do. do. No. 258.
 Document H. R., 3d session 25th Congress, No. 24.
 Document Senate, 1st session 26th Congress, No. 474.
 Do. do. do. No. 619.
 Document H. R., 2d session 27th Congress, No. 140.
 Do. do. do. No. 193.
 Do. do. do. No. 274.
 Do. do. do. No. 811.
 Document H. R., 3d session 27th Congress, No. 183.
 Do. do. do. No. 199.
 Document H. R., 1st session 28th Congress, No. 38.
 Do. do. do. No. 62.
 Document Senate, 2d session 28th Congress, No. 166.
 Document Senate, 3d session 25th Congress, No. 190.
 Document H. R., 3d session 27th Congress, No. 282.
 Document Senate, 2d session 27th Congress, No. 983.
 Document H. R., 2d session 27th Congress, No. 740.
 Document Senate, 1st session 26th Congress, No. 58.
 Document Senate, 3d session 25th Congress, No. 160.
 Do. do. do. No. 131.
 Do. do. do. No. 187.
 Document Senate, 2d session 25th Congress, No. 189.
 Do. do. do. No. 254.
 Do. do. do. No. 15.
 Memoir of Colonel B. Aycrigg, on the Light-houses at Barfleur and Ostend : Document H. R., No. 190, 3d session 25th Congress.
 American Review, vol. I, No 3 : New York, March, 1845.
 Captain Cotton's History of the Trinity House, London.
 Edinburgh Review, No. cxv., vol. 57, p. 180.
 Do. do. No. cxxiii., vol. 61, p. 117.
 Do. do. No. cxxiv., vol. 61, p. 279.
 Transactions of the Royal Society, London : Drummond Light.
 Nautical Magazine, vols. 1 to 15, (1832 to 1846.)
 Encyclopædia Britannica, 7th edition : Edinburgh, 1842 ; vol. 5, article Burning-glasses.
 Annuaire pour l'an 1831, présenté au Roi, par le Bureau des Longitudes : Notices Scientifiques par M. Arago, p. 151 et p. 172.
 Ex. Document H. R., No. 14, 2d session 31st Congress.
 Rudimentary Treatise on Light-houses, by Alan Stevenson, C. E., &c., &c., &c. : London, 1850.
 Account of the Skerryvore Light-house, with notes on the illumination of Light-houses, by Alan Stevenson, LL.B., F.R.S.E., M.I.C.E., Engineer to the Northern Light-house Board : Edinburgh and London, 1848.
 Report of the Franklin Institute on the Dioptric System of Augustin Fresnel for the illumination of Light-houses. (Journal Franklin Institute 1849, '50.
 Account of the Holophotal system of illuminating light-houses ; being a description of the light of maximum intensity ; by Thomas Stevenson, F.R.S.E., F.R.S.S.A., civil engineer, Edinburgh, 1851.

Ex. document, first session, 30th Congress, No. 27.

Ex. document, special session Senate, No. 1.

Instruction pour le service des Phares lenticulaires, Paris, 1848.

An account of the cast-iron light-house tower on Gibbs' Hill on the Bermudas: by Peter Paterson; London, 1850.

An account of the construction and fitting up of the new light-house on the Moro castle at Havana, island of Cuba; first order lens apparatus. Franklin Institute Journal, July 1847.

Returns to Parliament of Northern lights for 1844, 1845, 1846, 1847, 1848, 1849 and 1850.

Returns to Parliament of British Colonial lights for 1846, 1849, 1850 and 1851. London.

Returns to Parliament of Trinity House Corporation lights for 1844, 1845, 1847 and 1848.

Returns to Parliament of Irish lights for 1846 and 1848.

Returns relating to the use of colza oil in Great Britain three cahiers, 1846.

Cast-iron light-houses, nautical magazine, June 1850.

Light-house economy, nautical magazine, May 1851.

Light-houses of the British colonies and possessions abroad: by Alexander Gordon, M. Inst. C.E., &c. London, 1848.

Parliamentary report on shipwrecks. London, 1843.

William Herschel on the reflection of light from surfaces of *speculum* metal, in the Philosophical transactions, vol. 90, page 64. London.

An account of the construction and price of lenticular sea-lights; catoptric and catadioptric, optical and mechanical portions. W. Wilkins, London, 1851.

Traité élémentaire de Physique, par E. Péclet. Paris, 1847.

Ex. document, first session, 30th Congress, No. 25.
Ex. document, special session, 30th Congress, No. 1.
Instruction pour le service des Poudres militaires, Paris, 1815.
An account of the first iron light-house tower on Eddystone, 1811 on the Bar-
mudas; by Peter Paterson, London, 1810.
An account of the construction and fitting up of the new light-house on
the Mores castle at Hvaran, island of Gubb; first order for apparatus.
Franklin Institute, report, July 1815.
Returns to Parliament of Northern lights for 1814, 1815, 1816, 1817,
1818, 1819 and 1820.
Returns to Parliament of British Colonial lights for 1816, 1817, 1818
and 1821. London.
Returns to Parliament of Trinity House Corporation lights for 1814,
1815, 1817 and 1818.
Returns to Parliament of Irish lights for 1816 and 1817.
Returns relating to the use of colza oil in Great Britain three years,
1816.
Cost-ion light-house, nautical magazine, June 1820.
Light-house economy, nautical magazine, May 1821.
Light-houses of the British colonies and possessions abroad; by Alcock
Gordon, M. Inst. C. E., &c. London, 1848.
Parliamentary report on shipwrecks. London, 1843.
William Hatched on the reflection of light from surfaces of aqueous
bodies, in the Philosophical transactions, vol. 90, page 64. London.
An account of the construction and price of lenticular sea-lights; con-
tinued and enlarged, optical and mechanical portions. W. Williams, Lon-
don, 1821.
Traité élémentaire de Physique, par E. Biot, Paris, 1817.

Senate documents

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